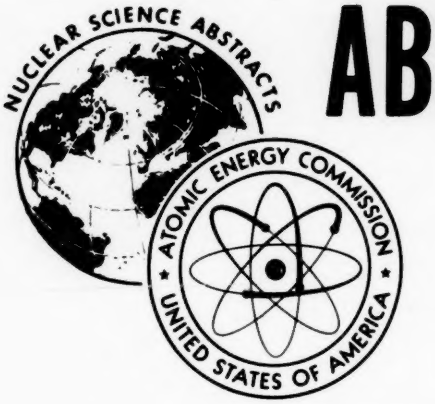
NUCLEAR SCIENCE ABSTRACTS



Volume 26 Number 4

Abstracts 6442-8673

February 29, 1972

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Volume 26, Number 4, February 29, 1972

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Personal Authors

Each author's name is indexed in the form appearing on the document abstracted:

NEWCOMB, William A., Stability of a magnetic well, 25:1239
NEWKIRK, L. R., Superconductivity in the pseudobinary alloys V_3Si--Nb_3Al, 25:1093 (CALT-822-13)
NEWLAND, E. A., Radiation treatment of sewage, 25:140 (AAEC/LIB/Bib-254)

Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

TRANSURANIUM ELEMENTS
determination in bone ash, radiochemical method for, 25:40 (IDO-12073, pp 28-36)
separation by ion exchange and complex-formation elution, 25:251(P)

TRIETHYLENETETRAMINE
complexes with cobalt(III) and rhodium(III) chlorides, radiation effects on labeled, thermal-neutron, 25:137

TRITIUM
content in Cattaraugus Creek near West Valley Processing Plant, July through Dec. 1969, 25:258 (DOCKET-50201-48)
content in Cattaraugus Creek near West Valley Processing Plant, Jan. to July 1970, 25:259 (DOCKET-50201-49)
determination in luminescent material by scintillation counting, 25:40 (IDO-12073, pp 28-36)

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Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

372 (UCRL–72739) CONSTRUCTION OF A UNIQUE UNDERGROUND WHOLE BODY COUNTER. Griffith, R. V.; Anderson, A. L.; Lindeken, C. L. **(California Univ., Livermore. Lawrence Radiation Lab.).** Oct 1970. 27p. (CONF-701009–1). Dep. NTIS.

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CALIFORNIA UNIV., LIVERMORE. LAWRENCE RADIATION LAB.
Construction of a unique underground whole body counter, 25:372 (UCRL-72739)

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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 6576 and 6799.

6442 (ARH-SA-104) ENVIRONMENTAL LABORATORY QUALITY ASSURANCE. Rochon, D. J. (Atlantic Richfield Hanford Co., Richland, Wash.). 15 Oct 1971. 7p. (CONF-71111-4). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

An environmental laboratory quality assurance program is discussed with respect to control of sampling, analytical methods, and instrumentation and intralaboratory and interlaboratory interaction. (D.H.M.)

6443 (IN-1491) ANALYTICAL CHEMISTRY BRANCH ANNUAL REPORT FISCAL YEAR, 1971. Shank, R. C. (Idaho Nuclear Corp., Idaho Falls). Jun 1971. Contract AT(10-1)-1230. 169p. Dep. NTIS.

The nonroutine, significant accomplishments by the Branch of analytical services and development work during the year at the National Reactor Testing Station are described. The areas covered are mass spectrometry, gas chromatography, atomic absorption spectrophotometry, emission spectrography, x-ray diffractometry, radiochemistry, spectrophotometry, titrimetry, gravimetry, quality control, remote techniques, and improvement of equipment and other analytical techniques. Additions to the analytical chemistry manual are included in the appendix. (auth)

6444 (MLM-1815) MOUND LABORATORY CHEMISTRY AND PHYSICS PROGRESS REPORT: JANUARY-MARCH 1971. (Mound Lab., Miamisburg, Ohio). 15 Nov 1971. Contract AT-33-1-GEN-53. 28p. Dep. NTIS.

GLOVE BOXES—plutonium-238 content in, evaluation of portable γ measuring technique for determining
NEPTUNIUM—entropy functions for trivalent and tetravalent
NEPTUNYL IONS—entropy functions for
PLUTONIUM—entropy functions for trivalent and tetravalent
 —determination in soil by fusion method
PLUTONIUM-238—determination in glove boxes, evaluation of portable γ-measuring technique for
 —half-life of, spontaneous fission
PLUTONYL IONS—entropy functions for
POLONIUM-210—sorption on noble metal surfaces, mechanisms of
SAMARIUM HYDRIDES—preparation by dissolution of samarium metal in acetic acid
SOILS—analysis for plutonium by fusion method
THORIUM-229—separation from uranium-233 by solvent extraction using di-sec-butyl phenylphosphonate
URANIUM—entropy functions for trivalent and tetravalent
URANIUM-233—separation of thorium-229 from, by solvent extraction using di-sec-butyl phenylphosphonate
URANYL IONS—entropy functions for (D.H.M.)

6445 INVESTIGATIONS ON RUBBER AND BRASS CONTACT. Azuma, Toshio; Sato, Yuji; Seiyama, Takeyoshi; Oka, Takashi; Yoshida, Toshio. Annu. Rep. Radiat. Center Osaka Prefect.; 11: 55-60(1970).

An air-tight contact between rubber and a brass rod was broken. The following three kinds of investigations are made to estimate its cause; investigation of the brass surface by electron and optical microscopes; investigation of the rubber surface by x-ray analysis; and investigation of elements in rubber by (γ,n) activation. The cause is considered mainly to be the brass surface treatment and also the element transference at the contact position. (auth)

6446 ANALITICHESKAYA KHIMIYA NEPTUNIYA. (Analytical Chemistry of Neptunium). Mikhailov, V. A. Analytical Chemistry of Elements. Moscow; Izdatel'stvo Nauka (1971). 223p.

A review is presented of the physicochemical features of Np and its compounds that are pertinent to the analytical techniques of the element. Such features include light absorption, hydrolysis, and complex formation, potentials, oxidation and reduction, and radiolysis. Methods are then detailed for the separation of Np from attendant elements, such as precipitation, coprecipitation, electrodeposition, and extraction systems. Fifty pages focus attention on quantitation of Np: radiometric, radioactivation, spectrophotometric, titrimetric, and electrochemical methods. The analyses of Np in special situations are described, such as in irradiated samples of various types. 306 references. (K.S.W.)

6447 AUTOMATIC CHEMICAL ANALYSIS. Guillot, P. (CEN, Fontenay-aux-Roses, France). Bull. Instrum. Nucl.; No. 42, 31-3(Jan 1971). (In French).

Automatic chemical analysis methods developed for industrial control of radioactive elements are briefly reviewed. The instrumentation used is described. (France)

6448 NUCLEAR ANALYTICAL CHEMISTRY. I. INTRODUCTION TO NUCLEAR ANALYTICAL CHEMISTRY. Toelgyessy, J.; Varga, S.; Krivan, V. Baltimore; University Park Press (1971). 271p.

The basic principles of nuclear physics and nuclear chemistry, detection and recording of nuclear radiation, the peculiarities of work with radioactive matters, and the principles of indicator analytical methods are discussed. (M.C.G.)

6449 ANALYTICAL MONITORING OF THE PRODUCTION OF NUCLEAR FUELS. Kuhn, Karl-Dieter; Muehling, Guenter; Scheffler, Knut (ALKEM GmbH, Wolfgang, Ger.). Chem. Ztg.; 95: No. 8, 350-5(1971). (In German).

In addition to radiochemical processes, well-known methods of analysis are applied and a special adaptation to the handling of radioactive material has to take place. The specification of accuracy and sensitivity of the analysis and the tolerance range within a production run oblige to new and further development and rationalization not only for the methods of measurement but also for methods of evaluation. A nuclear fuel that contains mixtures of oxides and carbides of Pu and U the specific analytical problems and processes used for it are described. (auth)

Chemical and Spectral Procedures

Refer also to abstracts 6946 and 6947.

6450 (EURFNR-909) DETERMINATION OF FLUORIDE, CHLORIDE AND BORON TRACES IN PLUTONIUM-CONTAINING OXIDE NUCLEAR FUELS. Mainka, E.; Coerdt, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Translation of report KFK-1360. 18p. Dep. NTIS.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

Fluorine, chlorine, and boron were separated from the matrix by pyrohydrolysis; a very simple, rapid and quantitative method.

The determinations of fluoride and chloride are based on potential measurements of a fluoride- or chloride-sensitive electrode, versus a mercury sulfate electrode. A spectrophotometric method was used for the determination of boron. (auth)

6451 (NP-19074) CONSTRUCTION AND OPERATION OF A ROTARY BURNER FOR FLUORIMETRIC URANIUM ANALYSIS. Ashbrook, A. W. (Department of Energy, Mines and Resources, Ottawa (Ontario). Mines Branch). May 1971. 17p. Information Canada Ottawa $0.50.

The construction and operation of a rotary burner, for use in the fusion of uranium-containing samples with sodium fluoride flux prior to the fluorimetric determination of uranium, is described. The burner consists essentially of an arrangement of LPG burners providing a circular flame through which dishes containing sample and flux are rotated. This arrangement results in even and reproducible heat distribution to the dishes, and provides good precision between individual fusions, and between replicate analyses. The burner is fitted for semi-automatic operation, which also increases the reproducibility of the fusion technique. (auth)

6452 DETERMINATION OF SODIUM AND POTASSIUM IN THE HIGH-MELTING METALS TUNGSTEN AND MOLYBDENUM BY ATOMIC ABSORPTION SPECTROSCOPY. Neumann, G. M. (OSRAM-Studiengesellschaft, Munich). Talanta; 18: No. 10, 1047-51(Oct 1971). (In German).

Results for the atomic-absorption behavior of sodium and potassium in the presence of large amounts of tungsten and molybdenum are reported. The mutual interference of the alkali metals is overcome by the addition of cesium. Of the matrix elements tungsten showed no interference, while molybdenum had a proportional interference effect, which can be overcome by keeping the specimen weight at a constant value. Thus, atomic absorption spectroscopy can be applied for the determination of K and Na in W and Mo without prior separation procedures. The sensitivity found for 1% absorption was 0.05 μg of alkali/ml of solution. (auth)

6453 DETERMINATION OF URANYL NITRATE AND NITRIC ACID BASES ON IN-LINE DENSITY AND CONDUCTIVITY MEASUREMENTS. Moeken, H. H. Ph. (Eurochemic, Mol, Belgium); Marchand, J. F. P.; de Vries, R. Anal. Chim. Acta; 57: No. 1, 230-2(Nov 1971).

The experimentally derived equation relating density and conductivity to the uranium- and acid-concentration values in the range 200 to 400 g U l^{-1} and 0.5 to 1.5 N acid are described. (D.H.M.)

6454 PRECISION AND ACCURACY OF SOME CURRENT METHODS FOR POTENTIOMETRIC END-POINT DETERMINATION WITH REFERENCE TO A COMPUTER-CALCULATED TITRATION CURVE. Anfaelt, Torbjoern; Jagner, Daniel (Univ., Goteborg). Anal. Chim. Acta; 57: No. 1, 165-76(Nov 1971).

Accurately calculated titration curves make it possible to select the optimal method for evaluating the end point of a particular potentiometric titration, with respect to systematic error, precision, and time required. The potentiometric titration of fluoride with thorium(IV) solution is used as an example. Decreasing systematic error is obtained by the different methods in the following order: methods based on sigmoid curves > differential methods based on $\Delta E/\Delta v$ plots > differential methods based on $\Delta v/\Delta E$ plots > methods based on mass-balance and equilibrium equations. Increasing precision is obtained in approximately the same order. The conclusions appear to be generally applicable and are useful in the construction of automatic titrators. (auth)

6455 TITRIMETRIC DETERMINATION OF URANIUM WITH FLUORIMETRIC END-POINT DETECTION. Koning, F. H. P.; den Boef, G.; Poppe, H. (Univ., Amsterdam). Anal. Chim. Acta; 57: No. 1, 159-63(Nov 1971).

The determination of uranium based on reduction of uranium(VI) to uranium(IV) and subsequent oxidation titration can be done by fluorimetric end point detection. In 0.2 to 1 M sulfuric acid solution, reduction by a Jones reductor was followed by oxidation with cerium(IV). The fluorescence of either uranium(VI) or cerium(III) can be utilized, the fluorimetric titration of 10^{-5} or 10^{-6} M solutions of uranium(IV), respectively, being possible. In 10.5 M phosphoric acid solution, uranium(VI) was reduced by iron(II), and uranium(IV) was titrated with dichromate. The limit of determination was 10^{-4} M in this case. (auth)

6456 COULOMETRIC DETERMINATION OF URANIUM AND IRON–URANIUM MIXTURES WITH FEEDBACK-CONTROLLED ELECTROLYSIS CURRENT. McCracken, J. E. (Univ. of Missouri, Columbia); Guyon, J. C.; Shults, W. D. Anal. Chim. Acta; 57: No. 1, 151-8(Nov 1971).

The determination of uranium and iron in mixtures of the two metals was accomplished by feedback-controlled electrolytic oxidation in the presence of a cerium(III) sulfate–sulfuric acid intermediate electrolyte. Samples were prereduced with an excess of chromium(II) to a mixture of U(III), U(IV), and Fe(II). The uranium was then determined by conversion of U(IV) to U(VI), and the Fe(II) was determined by oxidation to Fe(III). The progress of these titrations was followed by zero-current potentiometry with a platinum indicator electrode. Determinations of 5-mg quantities of uranium can be made with a precision of 0.04%; at the 5-μg level the precision is 4.5%. In the presence of 5 mg of uranium, determinations of 1-mg amounts of iron were made with an accuracy and precision of ±0.02%. (auth)

6457 TRANSIENT PHENOMENA OF ION-SELECTIVE MEMBRANE ELECTRODES. Toth, Klara; Gavaller, Istvan; Pungor, Ernoe (Technical Univ., Budapest). Anal. Chim. Acta; 57: No. 1, 131-5(Nov 1971).

A method of studying the response time of the ion-selective electrodes was worked out. An exponential equation was derived to describe the response of the electrodes. The potential of the silver halide electrodes reaches a constant value within a few hundred milliseconds, from which it follows that these electrodes can be used advantageously as sensors in flowing and control systems. Suitable measuring units and methods were worked out and the response times of the halide, cyanide, and sulfide ion-selective electrodes were determined. (auth)

6458 DETERMINATION OF THORIUM IN PLUTONIUM METAL BY LINEAR SWEEP OSCILLOGRAPHIC POLAROGRAPHY. Plock, C. E.; Vasquez, J. (Dow Chemical Co., Golden, Colo.). Anal. Chim. Acta; 57: No. 1, 113-21(Nov 1971).

The polarographic determination of thorium in plutonium is described. The plutonium is separated by anion exchange in a chloride medium, and the thorium is determined in the eluate by means of Superchrome Garnet Y in a buffered solution at pH 8.0. The thorium concentration range in the polarographed solutions is 8.5×10^{-6} to $3.4 \cdot 10^{-4}$ M. The average recovery of thorium is 99.3% with a relative standard deviation of 5.2%. Of the 32 diverse ions investigated, only aluminum, chromium, manganese, nickel, and lead cause significant interference. (auth)

6459 ANALYTICAL SEPARATION OF URANIUM AND THORIUM BY LIQUID ANION EXCHANGERS. Cospito, M.; Rigali, L. (CAMEN, Pisa, Italy). Anal. Chim. Acta; 57: No. 1, 107-11(Nov 1971).

A liquid–liquid extraction separation of uranium and thorium from each other and from interfering ions is described. Uranium is separated from sulfate solutions with a tertiary amine (tricaprylamine) and thorium from nitrate solutions with a quaternary ammonium salt (Aliquat-336). The method was successfully applied to the analysis of effluents from a miniature reprocessing plant and to the determination of thorium in low-grade ores. (auth)

6460 SPECTROPHOTOMETRIC DETERMINATION OF ZIRCONIUM IN STEELS WITH ARSENAZO III. Pakalns, P. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Anal. Chim. Acta; 57: No. 1, 51-7(Nov 1971).

A general method is presented for the spectrophotometric determination of zirconium in steels with Arsenazo III. Steel samples are dissolved by fuming with perchloric acid and zirconium is separated with cupferron, iron being used as carrier. The only interference is caused by titanium, but as little as 2 and 5 ppm of zirconium can be determined in steels containing 1 and 2.5% of titanium, respectively. Titanium can also be separated with cupferron and subsequently determined as the yellow titanium–peroxide complex. (auth)

6461 INTERFERENCES IN THE DETERMINATION OF TITANIUM, ZIRCONIUM, AND HAFNIUM BY ATOMIC ABSORPTION SPECTROPHOTOMETRY. Panday, V. K. (Varian Techtron Pty. Ltd., Springvale, Australia). Anal. Chim. Acta; 57: No. 1, 31-43(Nov 1971).

The effects of various ions and compounds on the atomic absorption signals of titanium, zirconium, and hafnium were investigated. The effect appears to be periodic in nature, the smallest ions usually causing the largest effect. The absorption of titanium is usually increased, but that of zirconium and hafnium is generally decreased. (auth)

6462 ION EXCHANGE SEPARATION AND COLORIMETRIC DETERMINATION OF Nb, Ta, W, AND Ti IN SOLUTIONS OF TANTALUM–NIOBIUM ORES. Foldzinska, Aleksandra (Inst. of Nuclear Research, Warsaw). Chem. Anal. (Warsaw); 16: No. 4, 821-32(1971). (In Polish).

An ion-exchange method was applied for separation of Ti, W, Nb, and Ta in tantalum–niobium ores before the colorimetric determination of these elements. The separation was carried out in the systems: Dowex 1 × 4 and Dowex 1 × 8 (100 to 200 mesh) – $H_2C_2O_4$ + HCl + H_2SO_4. It was found that the separation is affected by the cross linking of the resin (R^{Nb-Ta} amounts to 1.09 and to 0.81 for Dowex 1 × 4 and Dowex 1 × 8, respectively). The effect of common elements occurring in tantalum – niobium ores was examined. The elaborated method enables the determination of Ti, W, Nb, and Ta in amounts ranging from traces up to grams in the presence of Fe, Mn, K, Na, Zr, Ca, Mg, and Mo. Statistical analysis of results has shown that the true value is contained within the limits $\bar{x} \pm 19\%$. (auth)

6463 ABSORPTIOMETRIC DETERMINATION OF COBALT AND NICKEL IN TELLURIUM. **Kozera, Franciszek; Kasterka, Barbara (Inst. of Inorganic Chemistry and Tech., Danzig). Chem. Chem. Anal. (Warsaw); 16: No. 4. 925-32(1971). (In Polish).**

Absorptiometric methods for the determination of traces of cobalt and nickel were elaborated. Cobalt was determined by a selective method based on the reaction with 1-nitroso-2-naphthol using toluene as a solvent. Nickel was determined by a selective method based on extraction of the dimethylglyoxime complex and absorbance measurement at $\lambda_{max} = 263$ nm. The excess of dimethylglyoxime was removed by means of 0.1 M NaOH. Specific absorbance of the Ni dimethylglyoxime complex amounted to $0.403 \pm 0.03\ \mu g^{-1}\ cm^2$ at the $\lambda_{max} = 263$ nm. The limit of determination for nickel was found to be 0.5 μg/ml for the cell thickness equal to 2 cm at the confidence level of 99% for n = 6. Tellurium was separated as $TeO_2 \cdot nH_2O$. However, when its content is lower than 300 mg in the sample, it does not interfere with the determination. The preconcentration coefficient for cobalt and nickel was found to be 39.2 ± 8.5. The amounts of cobalt and nickel determined in the samples of pure tellurium varied within the limits of $5.67 \times 10^{-5}\% \pm 1.16 \times 10^{-5}\%$ and $26.23 \times 10^{-3}\% \pm 1.36 \times 10^{-4}\%$, respectively. (auth)

6464 COLORIMETRIC DETERMINATION OF SMALL AMOUNTS OF IODIDES AND IODATES BY MEANS OF N,N'-BIS(β-HYDROXYPROPYL)-o-PHENYLENEDIAMINE. Paslawska, Stefania (Dept. of Inorganic Chemistry, Danzig). Chem. Anal. (Warsaw); 16: No. 4, 951-5(1971). (In Polish).

An analytical procedure based on measuring the absorbance of a colored oxidation product of the reaction between N,N'-bis(β-hydroxypropyl)-o-phenylenediamine (DHPF) and iodine was developed. Molar absorptivity at maximum of absorption (λ = 525 nm) amounted to 51400. The solutions obeyed Beer's law over the concentration range 0.1 to 3.0 μg I/cm^3. The elaborated procedure can be used for the determination of iodates or iodides after oxidizing them with bromine water at pH 2.8. Separation of free iodine was effected with CdI_2 solution which reacts with the excess of iodides forming a stable complex. The measurements should be carried out in solutions free of other oxidizing ions. The method was used for the determination of iodine content in water from Vistula River at Swibno. (auth)

6465 DIRECT SPECTROPHOTOMETRIC DETERMINATION OF HIGH CONTENT OF FLUORIDE IN SOME URANIUM MATERIALS. **Nowicka-Janowska, T. (Inst. of Nuclear Research, Warsaw). Chem. Anal. (Warsaw); 16: No. 4, 961-3(1971). (In English and Polish).**

The influence of uranium on the determination of fluoride with lanthanum chelate of Alizarin Complexan (AC) was studied. The order of addition of reagents, the mole ratio of lanthanum to AC and other factors influencing the determination of fluoride in the presence of uranium were studied. It was found that fluoride can be determined without separation from uranium at the mole ratio La : AC = 1 : 1, but solution of the sample must be added to previously mixed reagents: solutions of AC, buffer, lanthanum and acetone. The reproducibility of the method is sufficient for control of technological processes. The relative standard deviation calculated from 6 independent determinations of fluoride in ammonium polyuranate sample was: 0.020 for the mean 0.801% with the scatter of results 0.775% to 0.820% and 0.017 for the mean 4.14% with the scatter 4.02% to 4.20%. (auth)

6466 DETERMINATION OF TERBIUM BY COMPLEX FORMATION WITH ANTIPYRINE. **Tishchenko, M. A.; Alakaeva, L. A.; L. A.; Poluektov, N. S. (Inst. of General and Inorganic Chemistry, Kiev). Ukr. Khim. Zh.; 37: No. 6, 591-4(Jun 1971). (In Russian).**

2,3-Dimethyl-1-phenyl-5-pyrazolone (antipyrine) in sodium tetraphenylborate reacts with rare earth element ions to form water-insoluble compounds. In the case of Sm, Eu, Tb, and Dy such complexes fluoresce in uv light. The ratios of the reacting components in the complexes are: metal/antipyrine/TPB = 1/6/3. The sensitivity of the method as applied to mixtures of rare earth elements is 0.01% Tb_4O_7. (tr-auth)

6467 MASS SPECTROSCOPY IN GEO AND COSMO CHEMISTRY: AN OVERVIEW. **Herzog, L. F. (Nuclide Corp., State College, Pa.). J. Mass Spectrom. Ion Phys.; 4: No. 4, 253-65 (Jul 1970).**

The applications of mass spectroscopy to the study of the earth and solar system are reviewed. Examples are given for determining geological ages, trace element analysis of blood, body fluid, and tissues, analysis of lunar samples, and for helping to determine physiological responses to stress. (D.H.M.)

6468 SPECTRAL DETERMINATION OF MERCURY, ARSENIC, AND TELLURIUM IN SULFIDES. **Yanochkina, Z. A.; Malyanov, V. V. Geokhim. Sb.; No. 4, 170-5(1969). (In Russian).**

The absence in the discharge gap of elements of lower ionization potential than those to be determined is the principal requirement for efficient determination of Hg, As, and Te. This can be achieved by fractional distillation of volatile elements. The second requirement is separate evaporation to produce the most intense spectra; for this purpose, special electrodes are used. Hg, As, and Te are determined by using an Fe electrode which is in the form of a cylinder drilled out to the diameter of the graphite electrodes. A graphite stopper was set in the upper part. The ground sample was charged into Fe electrode up to 3 mm from the edge. The weighed sample, containing 300 to 500 mg of the test material, was moistened with water and calcined. The arc was excited between the end of the C stopper and conventional conical upper graphite electrode. The sample was burned for 30 sec at 6 A, 30 sec at 9 A, finally at 13 A. The total exposure was 2 min. A single-lens ISP-28 spectrograph of medium dispersion was used with a slit width of 0.012 mm and 5 mm intermediate diaphragm. Spectra were recorded on SP-2 plates having sensitivity of 11 units. (Selenium-Tellurium Abstr.)

6469 COULOMETRIC TITRATION OF DICHROMATE AND CERIC IONS. **Mitev, S.; Damyanov, N.; Agasyan, P. K. Vestn. Mosk. Univ., Ser. II. Khim.; 12: No. 4, 500-1(Jul-Aug 1971). (In Russian).**

Ferrous ions electrogenerated from acidified solution of ferric ammonium sulfate were used for rather accurate coulometric determination of small amounts of dichromate and ceric ions present together. Dichromate and ceric ions were titrated in one part of the solution. Dichromate ions were titrated in another portion of the solution after preliminary reduction of ceric ions by sodium azide or chloride ions. The end point was detected by o-phenanthroline. (auth)

6470 HIGH-TEMPERATURE PYROLYSIS FOR THE QUANTITATIVE DETERMINATION OF HALOGENS IN ORGANIC SUBSTANCES. COMMUNICATION 1. DESTRUCTION METHOD. **Chumachenko, M. N.; Alekseeva, N. N.; Egorushkina, M. V. (Inst. of Chemistry of Natural Products, Moscow). Zh. Anal. Khim.; 26: No. 8, 1625-9(Aug 1971). (In Russian).**

Hydrogen formed during the thermal decomposition of an organic substance is an effective hydrogenating agent for chlorine, bromine, and iodine under static conditions in a closed volume. A method is suggested for the quantitative isolation of halogens (chlorine, bromine, iodine) from organic compounds as the respective halogen hydrides. It was proved that there is no water vapor in the pyrolysis products. A reaction chamber for hydrogenation is suggested. (auth)

Isotope Dilution Procedures

6471 OPTICALLY ACTIVE CO-ORDINATION COMPOUNDS. PART XXVI. DETERMINATION OF THE OPTICAL PURITY OF COBALT COMPLEXES BY THE METHOD OF ISOTOPE DILUTION. **Gillard, R. D.; Lyons, J. R. (Univ. of Kent, Canterbury, Eng.). J. Chem. Soc., A: No. 18, 2817-20(1971).**

The method of isotope dilution was used to determine the optical purities of samples of partially resolved salicylatobis(ethylenediamine)cobalt(III) nitrate and of oxalatobis(ethylenediamine)cobalt(III) chloride, and hence to obtain values of $\Delta\epsilon_{max}$ for peaks in the circular dichroism spectra of the fully resolved complex ions. (auth)

6472 DETERMINATION OF ZINC IN STANDARD REFERENCE MATERIALS BY ISOTOPE DILUTION AND ATOMIC ABSORPTION ANALYSIS. **Rosman, K. J. R.; Jeffery, P. M. (Univ. of Western Australia, Nedlands). Chem. Geol.; 8: No. 1, 25-32(Jul 1971).**

Zinc was determined in a range of standard reference materials using stable isotope dilution and atomic absorption spectrophotometry. Provided that samples were first passed through an ion exchange column to reduce the level of contaminating species, the atomic-absorption method yielded results in general agreement with the isotope dilution values. (auth)

Radiometric and Radiochemical Procedures

Refer also to abstracts 6712, 6773, 6841, 6842, and 6904.

6473 EVALUATION OF LIQUID SCINTILLATION SYSTEMS FOR THE ASSAY OF TRITIATED INULIN. McEvoy, Arthur F.; Harris, Wayne G. (New England Nuclear Corp., Boston). Anal. Biochem.; 43: No. 1, 123-8(Sep 1971).

Three liquid scintillation counting systems are presented for the determination of inulin-methoxy-^{3}H. Depending on the amount of radioactivity present and the degree of accuracy demanded, the appropriate scintillation solution can be conveniently selected from one of these. (auth)

6474 RADIOCHEMICAL SEPARATION OF TECHNETIUM FROM MIXED FISSION PRODUCTS. Swindle, D. L.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Radiochem. Radioanal. Lett.; 7: No. 4, 229-34(15 Aug 1971).

A radiochemical procedure is presented for determination of technetium activities from mixed fission products of uranium or thorium. The chief decontaminating step is the extraction of TcO_4^- into a tetrapropyl ammonium hydroxide–bromoform mixture from 4.0M NaOH solutions. γ-Spectra and low-level β^- counting were employed to calculate decontamination factors of $\approx 10^7$ with chemical yields of 50 to 70%. (auth)

6475 IMPROVED METHOD FOR COUNTING RADIOISOTOPES ABSORBED ON SILICA GEL. Shaw, Walter A.; Harlan, William R. (Univ. of Alabama, Birmingham). Anal. Biochem.; 43: No. 1, 119-22(Sep 1971).

The method eliminates the phenomenon of self absorption by dissolving the silica gel thin-layer chromatography absorbent with HF. The resulting mixture is then counted in a toluene–Triton X-100 scintillation solution. The maximum efficiencies for tritium and ^{14}C in the HF system are 32 and 87%, respectively. (M.C.G.)

6476 COMPARISON OF GEIGER–MUELLER AND LIQUID SCINTILLATION COUNTING METHODS IN ESTIMATING PRIMARY PRODUCTIVITY. Ward, F. J. (Univ. of Manitoba, Winnipeg); Nakanishi, Masami. Limnol. Oceanogr.; 16: No. 3, 560-3(May 1971).

Primary productivity estimated from liquid scintillation counting of the radioactivity of wet ^{14}C-labeled algae on membrane filters was about 30% greater than an estimate from Geiger-Mueller (G-M) counts of comparable algae and filters that were desiccated. A subsequent estimate from recounts of the G-M filters by the scintillation procedure was 21% less than that obtained from scintillation counts of wet filters. Most of the difference between the two methods is probably caused by the drying procedure required in sample preparation for G-M counting. The remaining difference, about 9%, may have been caused by variability in estimates of the specific activity of ^{14}C added to the incubation bottles (±7%) and errors associated with estimating zero-thickness activity of $^{14}C\text{-}BaCO_3$ precipitates. (auth)

6477 METHOD FOR MEASURING RADON AND THORON EXHALATION FROM THE GROUND. Megumi, Kazuko; Mamuro, Tetsuo. Annu. Rep. Radiat. Center Osaka Prefect.; 11: 40-3 (1970).

A method for determining directly the rates of radon and thoron exhalation from the ground was studied. In this method radon and thoron are directly adsorbed on granular activated charcoal distributed on the ground, and then the charcoal is subjected to γ spectrometry. The radon quantity is determined from the area of the photopeak due to 0.61-MeV γ rays of ^{214}Bi and the thoron quantity from the area of the photopeak due to 2.61-MeV γ-rays of ^{208}Tl. Several experimental results are presented. (auth)

6478 DETERMINATION OF ^{147}Pm IN IRRADIATED NUCLEAR FUEL. Joon, K.; Den Boef, R.; De Wit, R. (Institutt for Atomenergi, Kjeller, Norway). J. Radioanal. Chem.; 8: No. 1, 101-6(Jun 1971).

In the analysis of high-burnup PuO_2 fuel, Pm was determined by liquid scintillation counting, while the yield of the preceding chemical separation was determined by γ-spectrometric analysis of the spike ^{149}Pm. (M.C.G.)

6479 CONTROL OF THE COOLANT AND MODERATOR OF A NUCLEAR POWER PLANT WITH THE AID OF GAS CHROMATOGRAPHY. Pietrik, I.; Vespalec, R. (Power Research Inst., Bratislava). J. Radioanal. Chem.; 8: No. 1, 61-74(Jun 1971).

Some complex analytical problems connected with the operation of nuclear power plants cooled with gas and moderated with heavy water can be solved by combination of the high separation efficiency of gas chromatography with the sensitive and selective detection of radioactive radiation. The main fields of application of these methods are the control of the coolant, of gaseous wastes, and the control of the isotopic purity of heavy water. A review of papers dealing with these problems is given describing the procedures, methods, and the results achieved. (108 references) (auth)

6480 ETHANE PREPARATION FROM ATMOSPHERIC HUMIDITY WITH NATURAL TRITIUM CONTENTS. Seliga, M. (Comenius Univ., Bratislava). J. Radioanal. Chem.; 8: No. 1, 33-8(Jun 1971).

Atmospheric humidity in the surroundings of the A-1 atomic power station is taken off by means of an absorption equipment in order to measure natural tritium concentration in the atmosphere. Atmospheric water is reduced with Mg at 580°C, and the hydrogen obtained is used for catalytic hydrogenation of acetylene. Optimum conditions of ethane preparation in dependence of temperature, molar ratio of the components, flow rate and the number of hydrogenation cycles when using the new selective nickel catalyst 40-01 are reported. (auth)

6481 NEW RADIOMETRIC TITRATION METHOD BASED ON SEPARATION BY MEANS OF ION EXCHANGE. VI. THE REDUCTOMETRIC DETERMINATION OF THALLIUM. Heijink, A.; Polak, H. L. (Univ., Amsterdam). J. Radioanal. Chem.; 8: No. 1, 23-6(Jun 1971).

It is shown that the necessary phase separation in radiometric titrations can be achieved by cation exchange. The reductometric determination of trivalent thallium with hydrazine sulfate in sulfuric acid medium is chosen as an example. Concentrations of thallium down to 6×10^{-5} M were determined. (auth)

6482 NEW RADIOMETRIC TITRATION METHOD BASED ON SEPARATION BY MEANS OF ION EXCHANGE. V. THE OXIDIMETRIC DETERMINATION OF THALLIUM IN THE PRESENCE OF OTHER METALS. Heijink, A.; Polak, H. L. (Univ., Amsterdam). J. Radioanal. Chem.; 8: No. 1, 13-21(Jun 1971).

It is shown that the radio-oxidimetric titration of monovalent thallium is possible even in the case when other metal ions are present in thousand-fold excess. Nitrate and copper interfere. Some examples are given of mixtures of thallium with tin, cobalt, or iron, in which both ions are determined. (auth)

6483 RADIOMETRICHESKOE TITROVANIE. (Radiometric Titration). Mar'yanov, B. M. Moscow; Atomizdat (1971). 168p.

This monograph deals with the principles, theoretical aspects, and the field of application of radiometric titrimetry. Precipitation methods, complex formation reactions, and oxidation-reduction processes including liquid amalgams are presented. Radiocoulometric titrations, and titrations based on matter–radiation interactions are topics considered. The practical application of the subject to organic and inorganic substances is summarized. An extensive table summarizes in outline form the radiometric titrimetric procedures for ions from Ag^- to Zr^{4-}, plus 26 organic compounds. A similar table is devoted to complex-formation methods. 153 references. (K.S.W.)

6484 LIQUID SCINTILLATION COUNTING AS AN ANALYTICAL TOOL. Gibson, J. A. B.; Lally, A. E. (Atomic Energy Research Establishment, Harwell, Eng.). Analyst; 96: No. 1147, 681-8(Oct 1971).

A review of the subject is given under the headings: basic concepts; instrumentation; solvents, scintillators and additives; techniques (sample preparation for homogeneous systems, sample preparation for heterogeneous systems, sample preparation for Cherenkov counting, standardisation, data handling); and isotopes measured in a liquid scintillation counter. (39 references) (UK)

6485 LIQUID SCINTILLATION COUNTING OF ^{45}Ca IN GEOCHEMICAL STUDIES. Sharma, G. D.; Barsdate, R. J. (Univ. of Alaska, College). Contract AT(04-3)-310-PA4. Chem. Geol; 8: No. 1, 33-6(Jul 1971).

A simplified method for the use of radioactive calcium in experimental geochemistry is described. The technique accommodates aqueous samples from 1.0 to 3.5 ml with high and constant efficiency (50%). Solutions containing sea water, HCl, and organic complexing agent were assayed for ^{45}Ca with a precision of ±3% for one standard deviation. The use of Triton X-100 in the two-phase emulsion liquid-scintillation method reduced self absorption and sample-preparation problems usually associated with the counting of aqueous samples of beta emitters such as ^{45}Ca. With this technique the application of radioisotope methodology to the study of calcium is facilitated. (auth)

6486 RADIOMETRIC METHOD FOR DETERMINATION OF Ca ISOTOPE SHIFT. Moeller, P.; Papendorff, H. Hahn-Meitner-Institut, Berlin). Radiochem. Radioanal. Lett.; 8: No. 4, 241-50(5 Dec 1971). (In German).

A simple radiometric method is described by which the isotope shift of ^{45}Ca in laboratory experiments can be measured during the precipitation of calcite from ^{45}Ca-labeled bicarbonate solutions. The standard deviation of a single determination for a pair of precipitate–solution measurement was found to be ±1.4% per mass unit. (auth)

6487 NEW ASSAY TECHNIQUE FOR REACTIONS THAT PRODUCE RADIOACTIVE GASES. Wilson, Samuel H.; Kronick, M. N. (National Institutes of Health, Bethesda, Md.). Anal. Biochem.; 43: No. 2, 460-7(Oct 1971).

A technique is described for the radioassay of gas-producing reactions. The technique is simple and rapid and involves a closed reaction system and gas-solid scintillation counting with scintillator plastic. (auth)

6488 DETERMINATION OF U AND Th IMPURITIES IN MICA BY FISSION TRACK METHOD IN ORDER TO USE THIS MINERAL AS A DETECTOR OF HEAVY PARTICLES. Sandru, P.; Danis, Ana (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 1, 95-103(1971).

Several advantages of the muscovite mica as compared to other dielectrics used in the detection of heavily ionizing particles are shown. The methods of the U determination are described and the advantages of the induced-fission track method over the fossil-fission track method are presented. Also, the method of Th impurity determination is described. Low U and Th concentrations have been determined in this way for biotite and muscovite mica samples and values of 10^{-10} to 10^{-8} (at. U or Th/at. mica) have been found. The possibilities of measuring a U concentration of 10^{-15} (at. U/at. mica) are shown also. (auth)

Activation Procedures

Refer also to abstract 6571.

6489 (AERE-R-6910) USE OF NON DESTRUCTIVE γ ACTIVATION FOR THE ANALYSIS OF ROCK AND BIOLOGICAL MATERIALS. Hislop, J. S.; Williams, D. R. (Atomic Energy Research Establishment, Harwell (England)). Sep 1971. 24p. Dep. NTIS (U. S. Sales Only).

High energy (35 to 40 MeV) γ photon activation and high resolution γ ray spectrometry were used for the intact analysis of the standard rock materials W-1, G-1, and BCR-1, and Apollo 12 returned samples 12022 and 12065, and the reference biological material kale. Simultaneous irradiation of appropriate synthetic standards containing thirty-nine elements has shown that the technique is particularly valuable for the determination of iron, calcium, titanium, strontium, zirconium, cesium, antimony, thallium, arsenic, rubidium, lead, mercury, and nickel. Provided chemical separations are carried out, sensitivities of 0.02 to 5 μg may be achieved. (auth)

6490 (CEA-CONF-1853) NUCLEAR REACTION ANALYSIS OF BORON AND OXYGEN IN SILICON. Ligeon, Emile; Bontemps, Andre (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Aug 1971. 27p. (CONF-710925-3). Dep. NTIS (U. S. Sales Only).

From International meeting on chemical analysis by charged particle bombardment; Namur, Belgium (5 Sep 1971).

The main characteristics of low-energy nuclear reaction analysis are summarized. The experimental set-up, in particular the target chamber arrangements, is described. The nuclear determination of B and O in a Si substrate is presented, a study was made of the sensitivity and accuracy and the competing reactions. Determination of B and O can be carried out in spite of the fact that these elements lead interfering reactions. Results concerning the homogeneity in the sample surface (for diffused or implanted boron), the diffusion study (SiO_2–Si exchange) and the profile measurements, are presented. (France)

6491 (CEA-N-1492) BORON AND OXYGEN ANALYSIS USING NUCLEAR REACTIONS. Bontemps, A.; Ligeon, E. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Aug 1971. 37p. (In French). Dep. NTIS (U. S. Sales Only).

The accuracy, sensitivity, and validity of the method used to analyze a B-doped oxidized Si substrate are discussed. Some applications to microelectronic studies are given: homogeneity of the doping, diffusion (SiO_2–Si exchanges), and impurity profile measurements. (France)

6492 (LYCEN-7122) INTERPRETATION OF PARASITIC PHENOMENA ENCOUNTERED WHEN DETERMINING THE OXYGEN CONTENT OF SILICON BY CHARGED PARTICLE ACTIVATION. Talvat, Michel (Lyon Univ. (France). Institut de Physique Nucleaire). May 1971. 53p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The production curves corresponding to the numerous radioelements induced in the Si matrix by 27-MeV deuterons and 54-MeV alpha particles were traced. The cross sections were estimated. It was shown that the production of ^{18}F at high energy can be interpreted only by reactions induced in the Si matrix. The simplest reaction possible was studied; this allowed an upper limit to the cross section to be determined. The contribution of this reaction to the different excited states of the particles emitted appears to be important. (France)

6493 AUTOMATIC INDUSTRIAL ACTIVATION ANALYSIS SYSTEM FOR SLURRIES USING A RADIOISOTOPE NEUTRON SOURCE. Blake, Kenneth R. (Nuclear-Chicago Corp., Austin, Tex.). Anal. Instrum.; 9: F.4.1-5(1971).

From seventeenth annual ISA analysis instrumentation symposium; Houston, Tex. (19 Apr 1971).

A neutron activation analysis system is described for the measurement of silica in iron ore processing streams. The system is currently being used on a 24-hour-per-day basis in an iron ore processing plant. A Pu-238-Be neutron source is used to activate the iron ore slurry which is continuously recirculated between the source and a NaI(Tl) detector. The system is automatically compensated for variation of the solids content of the slurry by means of a gamma-ray transmission gauge. The analyzer is computer coupled for rapid feedback of analysis results to the plant process control system. The standard deviation between neutron activation and wet chemistry silica analyses was found to be ±0.10% silica in the concentration range 3 to 11% silica. (auth)

6494 NEUTRON ACTIVATION ANALYSIS OF GOLD IN ARCHEAN IGNEOUS AND METAMORPHIC ROCKS OF THE RICE LAKE-BERESFORD LAKE AREA, SOUTHEASTERN MANITOBA. Stephenson, J. F.; Ehmann, W. D. (Univ. of Manitoba, Winnipeg. Univ. of Kentucky, Lexington). Econ. Geol.; 66: No. 6, 933-9(Nov 1971).

Gold abundances determined by the method of neutron activation are reported for 26 replicate analyses of a variety of igneous and metamorphic rocks. Samples analyzed come from scattered locations in and adjacent to an Archean greenstone belt containing numerous low-grade gold-quartz veins. Most of the richer veins are enclosed by mafic intrusions. Gold content ranged from 0.3 to 325 ppB in the various rocks analyzed. Gold abundances (0.6 to 1.9 ppB) for the quartz diorite, quartz monozonite and metavoleanic groups are fairly typical of younger rocks of similar composition. Explanations are put forward to account for the unexpectedly low gold content of the paragneiss samples (0.6 ± 0.4 ppB) and relative gold enrichment in one felsic dyke sample (6.1 ppB). There is evidence to indicate that the mafic intrusions may be the source rocks of the gold. Thus, in addition to the spatial relationship of the richer veins to the mafic intrusions the latter also contain an order of magnitude more background gold than other rocks in the area. Furthermore, gold is apparently depleted in altered diabase wall-rock adjacent to a vein in the San Antonio gold mine. Nonrepeatable replicate analyses observed in some mafic samples may be due to inhomogeneous distribution of gold between powder aliquots resulting from an erratic distribution of gold-rich host minerals. (auth)

6495 DEVELOPMENT OF AN ACTIVATION ANALYSIS METHOD, USING THE REACTION (p,2n) AND γ SPECTROMETRY. APPLICATION TO IRON DETERMINATION IN CHICKEN BLASTODERM. Bonnet-Masimbert, O.; Prenat, M. F.; Valentin, J.; Sengel, P. (Univ., Grenoble, France). Compt. Rend., Ser. D; 273: No. 3, 384-7(19 Jul 1971). (In French).

An activation analysis method using a 26-MeV proton beam was developed and applied to Fe determination. The quantity of iron measured in one blastoderm was compared to the weight of the ashes as a function of the stage. The continuous incorporation of iron from the stage of 1 somite to that of 16 somites follows an exponential rate. (France)

6496 NEUTRON ACTIVATION ANALYSIS OF SCANDIUM IN CLAYS. Craft, T. F. (Georgia Inst. of Tech., Atlanta). Radiochem. Radioanal. Lett.; 8: No. 3, 199-203(10 Nov 1971).

A method for the nondestructive determination of scandium in clay by neutron activation analysis is described, and results obtained by this method are presented. (auth)

6497 MICROANALYSIS OF Si AND S IN GaSb BY DIRECT OBSERVATION OF RESONANT NUCLEAR REACTIONS. Chemin, J. F.; Roturier, J.; Saboya, B.; Petit, G. Y. (CEN, Gradignan, France). Nucl. Instrum. Methods; 97: No. 2, 211-17(1971).

The method of direct observation of nuclear reactions is applied to the microanalysis of impurities. The use of the (p, p'γ) reactions is discussed in the case where resonant reactions are observed. Such a method allows, as indicated, a measurement of the profile of concentration. The results obtained in the determination of Si and S in GaSb are discussed. The sensitivity which is for example 2×10^{14} at cm^{-2} for S is compared to conventional techniques. (auth)

6498 DETERMINATION OF THE F CONTENT OF Al BY γ ACTIVATION ANALYSIS. Vialatte, Bernard (CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. C; 273: No. 4, 339-41(26 Jul 1971). (In French).

The $^{19}F(\gamma,n)^{18}F$ reaction makes it possible to determine the amount of F present in Al. If the photon energy is too high, the results may be falsified by side reactions involving Al nuclei. (France)

6499 NEUTRON ACTIVATION ANALYSIS OF HALOGENS IN DRUGS. Margosis, Michel; Tanner, James T.; Lambert, Joseph P. F. (Dept. of Health, Education, and Welfare, Washington, D. C.). J. Pharm. Sci.; 60: No. 10, 1550-5(Oct 1971).

A rapid, efficient, and highly specific method is presented for the determination of total chlorine, bromine, or iodine in various drugs. The halogen content is determined by nondestructive neutron activation and may be used for the presumptive assay of halogen-containing drugs in various dosage forms. The relative freedom from laboratory contamination, the independence from matrix effect, and the rapidity and specificity of analysis make this technique well suited for the determination of major elements in such complex substances as drugs. The method involves subjecting samples to thermal neutron bombardment and correlating the measured activity from the induced radionuclides of samples with that of standards. The radionuclides of interest in this study are ^{38}Cl, ^{80}Br, ^{82}Br, and ^{128}I, which are produced by a neutron reaction (n,γ) in a nuclear research reactor. (auth)

6500 ELEMENTAL ANALYSIS BY ELASTIC SCATTERING. Jolly, R. K.; White, H. B. Jr. (Michigan State Univ., East Lansing). Nucl. Instrum. Methods; 97: No. 2, 299-307(1971).

It is shown that elastic scattering of an intermediate mass projectile like an α-particle is an efficient way of determining the elemental composition of any material (biological, environmental, geological, metallurgical, etc.) in one measurement. This method is particularly suitable for detecting heavy elements ($A > 16$) in the presence of a bulk of light elements and also for determining the elemental composition of biological matter. In the former case sensitivities for detecting heavy elements in atomic concentrations of 10^{-6} to 10^{-9} are easily achieved with measurement times of the order of a few tens of minutes on several currently operational Van de Graaff and cyclotron accelerator facilities. Higher sensitivities are possible at beam currents much greater than a microampere. Results of elemental analysis on specimens of whole fish, whole human blood and cow's milk are presented. (auth)

6501 NEUTRON-ACTIVATION ANALYSIS OF AIRBORNE DUST. Mamuro, Tetsuo; Matsuda, Yatsuka; Mizohata, Akira; Takeuchi, Takayuki; Fujita, Akira. Annu. Rep. Radiat. Center Osaka Prefect.; 11: 1-13(1970).

Instrumental neutron activation analysis by γ spectrometry with a high resolution Ge(Li) detector followed by data processing with an electronic computer was applied to elemental analysis of airborne dust samples which were collected at four stations selected in Osaka district, and atmospheric concentrations of more than thirty elements (Na, Al, Cl, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Zn, As, Se, Br, Rb, Ag, Cd, In, Sb, Cs, Ba, La, Ce, Sm, Eu, Yb, Lu, Hf, Ta, W, Au, Hg, and Th) were found to be determinable. Airborne dust was continuously collected on a membrane filter of 4.7 cm in diameter and 1.2 μ in pore size during a month, and average concentrations in the atmosphere in the month were determined. Descriptions were made on preparation of the dust specimens and the standard reference specimens for irradiation, the radionuclides and their γ energies which were used for the determinations, future plans of observation and technical improvement, and so on. On comparison of the concentrations of each element at the four stations with one another, it was found that there seemed to be some characteristic trends in the relative concentrations of several elements at the four stations. It is thus proposed that measurement of atmospheric concentrations of as many elements as possible at many more stations provides an effective aid for grasping the situation of air pollution in a heavily polluted area, even though not all the analyzed elements are hazardous to public health. (auth)

6502 ACTIVATION ANALYSIS OF POLLUTED RIVER WATER. Mamuro, Tetsuo; Matsuda, Yatsuka; Mizohata, Akira; Takeuchi, Takayuki; Fujita, Akira. Annu. Rep. Radiat. Center Osaka Prefect.; 11: 14-28(1970).

Instrumental neutron activation analysis by γ spectrometry with a high resolution Ge(Li) detector followed by spectrum analysis with an electronic computer was applied to elemental analysis of a river water sample which was collected in a river into which pour liquid wastes from a tungsten mine, and the concentrations of 31 elements were determined. Among the elements were some metallic elements which are regarded as important from the viewpoint of environmental pollution, such as Cd, As, Sn, and Cr; it was thus confirmed that such instrumental neutron activation analysis is quite useful for elemental analysis of polluted river water. The presence of U was found by detecting ^{239}Np. Fluorescent x-ray analysis revealed the presence of Mo and Sr, but the concentrations of these two elements could not be determined by the present activation analysis. Attempts were made to determine concentrations of as many elements as possible, not limiting to heavy metallic elements. The information on the concentrations of many elements will be useful when comparing the elemental compositions of different river water samples with one another and attempting to realize the characteristic quality of a polluted river water, and therefore may be expected to provide basic data for establishing long term counter-plans against river water pollution. (auth)

6503 EXCHANGE REACTIONS OF ALKALINE-EARTH ELEMENTS ON MINERAL EXCHANGERS. Sanchez Batanero, P.; May, S. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Soc. Chim. Fr.; No. 7, 2749-54(Jul 1971). (In French).

The distribution coefficients of the ions Ca^{2+}, Sr^{2+}, and Ba^{2+} on zirconium phosphate (H^+ or NH_4^+) were studied in HCl and NH_4Cl media. The variation of the distribution coefficients was studied as a function of pH or NH_4Cl concentration. The distribution coefficients of alkaline earth metals on zirconium phosphate were then investigated in chelating media (DCTA) as a function of pH. The separation of these elements on elution columns was examined: barium was completely isolated, but the separation of the Ca–Sr couple was not total. An application to activation analysis was proposed. (France)

6504 RADIOANALYTICAL INVESTIGATION OF THE CESIUM SALT OF A RHODIUM(III)–IODIDE COMPLEX. Stella, R.; Di Casa, M. (Univ., Pavia, Italy). Radiochem. Radioanal. Lett.; 8: No. 3, 137-45(10 Nov 1971).

From a rhodium(III) chloride solution to which a large excess of iodide was added a cesium salt of a rhodium iodide anion was precipitated. The composition of this compound was determined by radioanalytical methods and a dimeric formula $Cs_4[Rh_2I_{10}]$ was suggested. Thermoanalytical measurements confirmed the radioactivation analysis data. (auth)

6505 AN ISOTOPE CATALOGUE FOR INSTRUMENTAL ACTIVATION ANALYSIS. I. Pagden, I. M. H.; Pearson, G. J.; Bewers, J. M. (Bedford Inst., Dartmouth, Nova Scotia). J. Radioanal. Chem.; 8: No. 1, 127-88(Jun 1971).

An isotope catalog is presented for use with computer programs for analysis of γ spectra from neutron-activated samples. The principal function of the catalog is to provide coefficients for isotope activities in a set of linear simultaneous equations. (M.C.G.)

6506 ACTIVATION ANALYSIS DETERMINATION OF THALLIUM IN ROCKS. A COMPARISON OF SEVERAL MEASUREMENT METHODS. Marowsky, G. (Univ., Goettingen, Ger.). J. Radioanal. Chem.; 8: No. 1, 27-32(Jun 1971). (In German).

In a series of rock samples, including some USGS standard rocks, thallium was determined by thermal neutron activation analysis. After complete radiochemical purification, the radioactivity of the samples was measured with conventional methane flow counters using the 97.9% β decay and by evaluating the Hg x rays from 2.1% electron capture of ^{204}Tl ($T = 3.8y$). With a Ge(Li) detector concentrations of 1 ppB (after 3 days irradiation at a thermal neutron flux of $6 \times 10^{13}\ n \cdot cm^{-2} \cdot sec^{-1}$) could be detected after a very simple radiochemical procedure based on ion exchange. (auth)

6507 NEUTRON ACTIVATION DETERMINATION OF GOLD IN ROCKS USING DIBUTYL SULFIDE EXTRACTION FOR GOLD SEPARATION. Gil'bert, E. N. (Inst. of Inorganic Chemistry, Novosibirsk, USSR); Guklhova, G. V.; Glukhov, G. G.; Mikhailov, V. A.; Torgov, V. A. J. Radioanal. Chem.; 8: No. 1, 39-43(Jun 1971).

A rapid method for determination of gold in rocks by neutron activation was developed. The method is based on quantitative and specific separation of gold with dialkyl sulfide extraction. (auth)

6508 SUBSTOICHIOMETRIC DETERMINATION OF TUNGSTEN BY NEUTRON ACTIVATION ANALYSIS. Nadkarni, R. A.; Haldar, B. C. (Inorganic and Nuclear Chemistry Lab., Bombay). J. Radioanal. Chem.; 8: No. 1, 45-51(Jun 1971).

A method for substoichiometric determination of tungsten by thermal neutron activation analysis was developed based on the selective extraction of the tungsten dithiol complex into amyl acetate. The method is simple, rapid, and accurate. It was used in the determination of tungsten in alloy steel, meteorites, and biological standard kale. (auth)

6509 SUBSTOICHIOMETRIC EXCHANGE EXTRACTION OF TANTALUM AND GOLD TETRAPHENYLARSONIUM. Bilimovich, G. N.; Churkina, N. N. (Inst. of Geochemistry and

Analytical Chemistry, Moscow). J. Radioanal. Chem.; 8: No. 1, 53-60(Jun 1971).

The conditions for substoichiometric exchange extraction in the system $[(C_6H_5)_4AsTaF_6]_{CHCl_3}-(AuCl_4^-)_w$ were investigated in order to establish the feasibility of substoichiometric separation of tantalum and its determination by activation. (auth)

6510 DETERMINATION OF SODIUM AND PHOSPHORUS IN ORGANOPHOSPHORUS COMPOUNDS BY FAST-NEUTRON ACTIVATION. Lisovskii, I. P.; Smakhtin, L. A. (Physical-Chemical Inst., Moscow). J. Radioanal. Chem.; 8: No. 1, 75-81 (Jun 1971).

A method is described for determination of sodium and phosphorus using the NG-160 neutron generator and an automated pneumatic transport device. The reactions $^{23}Na(n,p)^{23}Ne$ and $^{31}P(n,\alpha)^{28}Al$ are utilized for determination of sodium and phosphorus, respectively. For determination of sodium, hermetically sealed vials are indispensable. The time required for one determination is 6 to 8 min. A rapid method for determination of macro-amounts of sodium against a phosphorus background is also described, leading to the general conclusion that isotopes with γ-quantum energies close to 0.51 MeV can be determined against a background of positron radiation sources in a well-type crystal. (auth)

6511 NONDESTRUCTIVE DETERMINATION OF DYSPROSIUM IN GRAPHITES BY NEUTRON ACTIVATION ANALYSIS. Zmijewska, W. (Inst. of Nuclear Research, Warsaw); Sorantin, H. J. Radioanal. Chem.; 8: No. 1, 83-8(Jun 1971).

Natural graphites, graphite components, spectral and reactor grade graphites were analyzed nondestructively for dysprosium by neutron activation and γ spectrometry using ^{165m}Dy (1.2 min) and ^{165}Dy(2.3 hr). In four samples the determined Dy content was in the range 1.48 to 0.039 ppM. The deviation was ±18%. The limit of lower detection of the applied method amounts to 0.01 μg Dy, depending on the background contributed by other impurities. (auth)

6512 NEUTRON ACTIVATION ANALYSIS OF HEAVY RARE EARTHS. Becknell, D. E.; Voigt, A. F. (Ames Lab., Iowa). J. Radioanal. Chem.; 8: No. 1, 89-99(Jun 1971).

A method of nondestructive activation analysis of heavy rare earth elements (Sm–Lu) is described. Intensities of γ peaks are compared to that of an internal reference after irradiations by both thermal and fission spectrum neutrons. Results are obtained from computer comparisons of peak areas. (auth)

6513 APPLICATION OF ^{80m}Br TO THE SEMI-AUTOMATED ANALYSIS OF BROMINE IN BIOLOGICAL FLUIDS. Heurtebise, M.; Ross, W. J. (Instituto Venezolano de Investigaciones Cientificas, Caracas). J. Radioanal. Chem.; 8: No. 1, 5-12(Jun 1971).

A method is presented for determination of bromine in biological fluids that demonstrates the possibility of adapting neutron activation analysis to large-scale, routine programs. By means of a simple and inexpensive semi-automated system radioactive bromine is separated from 100 samples per day. A procedure for determining bromine through measurement of the 36-keV γ-ray of ^{80m}Br was developed and incorporated into this method. The advantages achieved with this multipurpose separation system and low-energy γ-spectrometry are demonstrated through analyses of urine, serum, plasma, and saliva. (auth)

6514 ACTIVATION ANALYSIS OF WATER IN THE RIVER YODO. Mamuro, Tetsuo; Matsuda, Yatsuka; Mizohata, Akira; Matsunami, Tadao; Takeuchi, Takayuki. Annu. Rep. Radiat. Center Osaka Prefect.; 11: 23-8(1970).

Instrumental neutron activation analysis by γ spectrometry with a Ge(Li) detector followed by data processing with an electronic computer was made on several water samples collected in the river Yodo which is the main source of tap water supply in Osaka district, and concentrations of about 30 elements were determined. From the results it is proposed that the material balance based on measured concentrations of many elements at various sampling points would provide an effective aid to search the origins of pollution as well as to understand the present situation of pollution. Concentrations of the most hazardous elements (Cd, Hg, and As) were not determined possibly because of their low concentrations and too small amount of samples analyzed, but an unexpectedly high concentration of Cr was found in the river Katsura, one of the main branches of the river Yodo. It was found that concentrations of Al, Sc, V, Fe, Co, Cs, La, Ce, Sm, Eu, Yb, Lu, Hf, Ta, and Th were much reduced by the treatment at a water purification plant. On the other hand, concentrations of Na, K, Se, Br, and Ag remained almost unchanged by the treatment. The number of determinable elements will be increased by making some improvements in the present technique and by the use of fluorescent x-ray analysis. (auth)

6515 QUANTITATIVE ANALYSIS OF Sr, Au, Br, Mn, AND Na IN NORMAL HUMAN ENAMEL AND DENTINE BY NEUTRON ACTIVATION AND HIGH RESOLUTION GAMMA SPECTROMETRY. Retief, D. H. (Univ. of the Witwatersrand, Johannesburg. South African Medical Research Council, Johannesburg); Cleaton-Jones, P. E.; Turkstra, J.; de Wet, W. J. J. Dent. Ass. S. Afr.; 26: 63-9(Mar 1971).

The concentrations of Sr, Au, Br, Mn, and Na in normal human enamel and dentine were determined employing instrumental neutron activation analysis. Their mean concentrations in enamel were 111, 0.11, 34, 0.59 ppM and 0.70 per cent, and in dentine 94, 0.07, 114, 0.63 ppM and 0.64 per cent, respectively. (auth)

6516 ANALYSIS OF NASHVILLE AIR POLLUTION VIA NEUTRON ACTIVATION ANALYSIS. Carlton, R. F.; Lehman, A. Jr. (Middle Tennessee State Univ., Murfreesboro). J. Tenn. Acad. Sci.; 46: No. 2, 63-5(Apr 1971).

By use of neutron activation analysis, Al, Cu, P, Mg, and Si were found in a sample of Nashville air pollution. The gamma ray analysis was carried out using both NaI and Ge(Li) detectors. The sensitivity of this method of analysis is discussed as well as some of the problems which might be encountered in such an analysis. (auth)

6517 DETERMINATION OF LOW OXYGEN CONTENTS IN METALS BY ACTIVATION WITH 14-MeV NEUTRONS. Nikolaenko, O. K.; Shtan, A. S. Tr. Vses. Nauch.-Issled. Inst. Radiats. Tekh.; No. 4, 183-6(1970). (In Russian).

The determination of 10 to 100 ppM of O in aluminum, titanium, iron, copper, or niobium, is based on the reaction $^{16}O(n,p)^{16}N$. The sample and standard (a metal of known O content or Plexiglas), in the form of discs are irradiated for 20 min in a neutron flux of $\approx 2 \times 10^{10}$ neutrons/sec from a suitable generator; 1 sec after the end of irradiation, the γ radiation from the ^{16}N is counted for 20 min in the range 3.5 to 7.5 MeV by means of a scintillation spectrometer [NaI(Tl) crystal]. The cycle of irradiation and measurement is repeated six times more. (Referativnyi Zh.)

6518 NEUTRON-ACTIVATION ANALYSIS OF BAUXITE AND NEPHELINE. Ivanov, I. N.; Markun, N. Yu.; Shtan, A. S. Tr. Vses. Nauch.-Issled. Inst. Radiats. Tekh.; No. 4, 186-93 (1970). (In Russian).

Two methods are described for the determination of Al, Si, and Fe in Al ores and products of their processing. The first method permits rapid determination of Al and Si by the reactions $^{27}Al(n,\gamma)^{28}Al$ and $^{28}Si(n,p)^{28}Al$, respectively. The sample is subjected to irradiations (once with, and once without, a cadmium shield) in a neutron flux of $\approx 2.4 \times 10^4$ neutrons/cm^2/sec from a ^{238}Pu–Be source, then the ^{28}Al is γ counted in the range 1.6 to 2.0 MeV with a single-channel scintillation spectrometer with a NaI(Tl) crystal, and the Al and Si contents are calculated. The limits of detection are 0.2% of Al_2O_3 (in samples containing $\approx$20% of SiO_2) and 1.1% of SiO_2 (in samples containing $\approx$5% of Al_2O_3). In the second method (which is more sensitive for Si and permits determination of Fe also), the sample is irradiated in a flux of $\approx 2.5 \times 10^5$ neutrons/cm^2/sec from a neutron generator; after the end of irradiation, the product is γ counted for ^{28}Al as before; 8 min after the end of irradiation, the product is γ counted in the range 0.7 to 1.2 MeV [for ^{27}Mg (from the Si) at 0.843 and 1.015 MeV, and for ^{56}Mn (from the Fe) at 0.845 MeV], and this measurement is repeated 24 min after the end of irradiation. The Al, Si and Fe contents of the sample are then calculated from simultaneous equations. An analysis takes 50 min, and the limits of detection (%) are Al_2O_3, 0.4; SiO_2, 0.3; and Fe_2O_3, 2.6. (Referativnyi Zh.)

6519 MICRODETERMINATION OF NUCLEIC ACID PHOSPHORUS BY NEUTRON ACTIVATION ANALYSIS. Sabbioni, Enrico; Clerici, Libero; Campagnari, Francesco; Girardi, Francesco; Bartolini, Paolo (Euratom Joint Research Center, Ispra, Italy). Biochemistry; 10: No. 23, 4185-9(9 Nov 1971).

Neutron activation analysis was standarized for the determination of DNA phosphorus down to 0.1 ng. The method was based upon the transformation of stable polynucleotide phosphorus into ^{32}P by capture of thermal neutrons and it included four steps: (1) irradiation of DNA in a nuclear reactor; (2) mineralization of the organic material in Teflon tubes by a $HNO_3-HCOOH-H_2O_2$ mixture changing all ^{32}P species into inorganic radiophosphate; (3) isolation of the $[^{32}P]PO_4^{3-}$ from contaminating radionuclides; (4) assay of ^{32}P by counting its Čerenkov effect in 6 M HF with the aid of a conventional apparatus for liquid scintillation spectrometry. For specimens with more than 100 μg of total phosphorus, oxidative acid digestion of the nucleotides, and separation of the ^{32}P from other radioelements were not always necessary. When such samples were prepared and activated under controlled conditions, the β^- emission of ^{32}P was measured directly in irradiated DNA without interferences after 1 week of decay. Except for neutron activation, all manipulations can be carried out in a normal biochemical laboratory. Some of the auxiliary techniques developed for the neutron activation analysis method may be applied in chemical assays of nucleic acid phosphorus for improving accuracy and sensitivity. (auth)

6520 RAPID NEUTRON ACTIVATION ANALYSIS OF BROMINE USING 6.1 MIN BROMINE-82m. Peisach, M.; Comar, D.; Kellershohn, C. (CEA, Orsay, France). Radiochem. Radioanal. Lett.; 8: No. 4, 267-76(5 Dec 1971).

X-ray spectrometry combined with neutron activation to produce the ^{82m}Br is a suitable method for the rapid determination of bromine in biological samples. With blood plasmas, small liquid samples are required. The method is sufficiently accurate to measure concentrations higher than the normal bromine concentration of 3 μg/ml and is sufficiently sensitive to measure bromine-depleted plasmas with concentrations below 1 μg/ml, but then a root mean square error of ±0.3 μg/ml should be acceptable. In the absence of high radioactivities, the sensitivity of the method is 0.35 ng bromine, and for liquids of constant composition the relative precision can reach 1 to 2%. (auth)

6521 DETERMINATION OF IRIDIUM IN ROCKS. Das, H. A.; Janssen, R.; Zonderhuis, J. (Reactor Centrum Netherland, Petten). Radiochem. Radioanal. Lett.; 8: No. 4, 257-65(5 Dec 1971).

A simple procedure for determination of iridium in rocks by neutron activation analysis is presented. The radionuclide used is ^{192}Ir (T = 74 d). The method of isolation is based on ion exchange with the chelating resin "Safrion NMRR." Data for a few standard rocks of the U.S. Geological Survey are given. (auth)

6522 SIMULTANEOUS DETERMINATION OF CHROMIUM AND ZINC BY NEUTRON ACTIVATION ANALYSIS. Nadkarni, R. A.; Haldar, B. C. (Inst. of Science, Bombay). Radiochem. Radioanal. Lett.; 8: No. 4, 233-40(5 Dec 1971).

Chromium and zinc were determined in standard rocks and standard biological materials by thermal neutron activation followed by the extraction of zinc with 5% tribenzylamine in $CHCl_3$. Chromium(III) was then oxidized to Cr(VI) and also extracted with 5% tribenzylamine in $CHCl_3$. Both Cr and Zn were finally precipitated as 8-hydroxyquinolinates. The method was used to determine these elements in standard rocks, such as GR, W1, Sye-1, and Pcc-1, and in biological standards: kale and tobacco 1R1. (auth)

6523 RADIOCHEMICAL PROCEDURE FOR TIN. Morris, D. F. C.; Denny, J. A. (Brunel Univ., Uxbridge, Eng.). Radiochem. Radioanal. Lett.; 8: No. 4, 219-23(5 Dec 1971).

A chemical procedure for the separation of radiotin from radionuclides of other elements is reported. Complete exchange between radioactive tin and carrier is achieved in a solution of hydrofluoric and nitric acids. The fluorocomplex of Sn(IV) is destroyed by addition of boric acid and "metastannic acid" is precipitated. The latter is tilized on a cold finger. The iodide is dissolved in aqueous perchloric acid–sodium iodide solution and extracted into benzene. After back-extraction into hydrochloric acid, Sn(IV) is finally precipitated with N-benzoylphenylhydroxylamine. The chemical yield approximates 80%. Quadruplicate analyses require about 3 hrs. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 7239, 8000, and 8227.

6524 SELECTED PAPERS IN HIGH-POLYMER PHYSICS. Meeting of the American Physical Society, 29 March–1 April 1971, Cleveland, Ohio. J. Appl. Phys.; 42: No. 12, 4543-4679 (Nov 1971). (CONF-710322).

Nineteen papers are included, covering such topics as: polymerization and crystallization, structure, mechanical and other properties, stress effects, and relaxation. A separate abstract was prepared for one of the papers. (D.L.C.)

For an abstract of an individual paper see: 6617.

6525 KINETICS AND MECHANISM OF POLYREACTIONS. VOLUME III. IUPAC International Symposium on Macromolecular Chemistry, Budapest, 25th–30th August, 1969. Budapest; Akademiai Kiado (1969). 445p. (In several languages). (CONF-690843–(Vol.3)).

Approximately 80 papers are included, divided into three sections: radical polymerization, radiation and photochemical polymerization, and polymerization in heterogeneous systems. Separate abstracts were prepared for seven of the papers. (D.L.C.)

For abstracts of individual papers see: 6565 and 6618–6623.

6526 KINETICS AND MECHANISM OF POLYREACTIONS. VOLUME IV. IUPAC International Symposium on Macromolecular Chemistry, Budapest, 25th–30th August, 1969. Budapest; Akademiai Kiado (1969). 373p. (In several languages). (CONF-690843–(Vol.4)).

Sixty-five papers are presented, arranged in two sections dealing with polymerization and polycondensation in the solid phase, and with grafting and crosslinking. Separate abstracts were prepared for 25 of the papers. (D.L.C.)

For abstracts of individual papers see: 6624–6647 and 6680.

6527 KINETICS AND MECHANISM OF POLYREACTIONS. VOLUME V. IUPAC International Symposium on Macromolecular Chemistry, Budapest, 25th–30th August, 1969. Budapest; Akademiai Kiado (1969). 497p. (In several languages). (CONF-690843–(Vol.5)).

Ninety-one papers are arranged in two sections dealing with polymer-analogous reactions (29 papers) and with depolymerization, degradation, and stabilization of polymers (62 papers). Separate abstracts have been prepared for eleven of the papers in the second section. (D.L.C.)

For abstracts of individual papers see: 6681–6691.

Chemical Properties

Refer also to abstracts 6715, 6724, 7241, and 7242.

6528 (CEA-R–4205) STUDY OF CONTROLLED FLUORINATION ON INTERMEDIATE URANIUM FLUORIDES. Rude, Henri; Benoit, Raymond; Hartmanshenn, Olivier (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug 1971. 33p. (In French). Dep. NTIS (U. S. Sales Only).

The reaction $UF_4 + ClO_3F$ was studied by different methods in a temperature range between 240 and 310°C. If a preliminary fluorination of UF_4 to UF_x takes place, the observed production of gaseous UF_6 is probably not due solely to a later fluorination of UF_x to UF_6 by ClO_3F. In fact, the intermediate formation of a uranium oxyfluoride is observed and this, on heating, itself cracks to give UF_6 and uranyl fluoride. It is difficult to determine the composition of this oxyfluoride. Results tally better with the formula $U_2O_2F_7$ also written (UO_2F_2, UF_5), than with the formula $UO_{0.5}F_4$ proposed by KIRSLIS for a similar compound. No UF_5- ClO_3F reaction takes place in the region 0 to 130°C. The reaction UF_4-F_2O studied between 175 and 250°C leads to approximately the same type of fluorination then oxyfluorination of UF_4 as the reaction UF_4-ClO_3F. In particular the intermediate solid compound and the final residue are the same. There is no UF_5-F_2O reaction in the range 0 to 130°C. The crystallographic structure of the uranium oxyfluoride described would show similarities with that of uranyl fluoride in which the substitution of O^{-} by F^{-} ions would correspond to a slight variation in the distances between the planes perpendicular to the C axis, and a lowered hexagonal symmetry. (auth)

6529 (DOCKET-408027–1) SEQUOYAH URANIUM HEXAFLUORIDE PRODUCTION PLANT. Statement of Reasons Why Operations of the Plant Should Not Be Suspended Pending Completion of NEPA Environmental Review. (Kerr-McGee Corp., Oklahoma City, Okla.). 15 Oct 1971. 7p. Dep. NTIS.

Reasons are given why operation of the Sequoyah UF_6 plant should be permitted to continue pending completion of the environmental review. The site, design and construction, environmental impact, biological impact, and radioactive discharge are discussed. (M.C.G.)

6530 (DOCKET-408027–2) SEQUOYAH URANIUM HEXAFLUORIDE PRODUCTION PLANT. Environmental Report. (Kerr-McGee Corp., Oklahoma City, Okla.). 8 Nov 1971. 26p. Dep. NTIS.

The environmental report includes: description of site and area, environmental approval, environmental impact, environmental surveillance program, results of plant use, alternatives, commitments of resources, and cost benefit analysis. (M.C.G.)

6531 (DOCKET-408027–3) SEQUOYAH URANIUM HEXAFLUORIDE PRODUCTION PLANT. Statement of Reasons Why Operation of the Plant Should Not Be Suspended Pending Completion of NEPA Environmental Review, Revised. (Kerr-McGee Corp., Oklahoma City, Okla.). 13 Nov 1971. 29p. Dep. NTIS.

Additional material is presented in support of the request for continued operation of the plant pending completion of the environmental review. Site selection, the process used, waste treatment, land use, water use, chemical discharge, gaseous effluents, solid wastes, environmental surveillance, and the effect of delay in facility operations are discussed. (M.C.G.)

6532 (DOCKET-408027-4) SEQUOYAH URANIUM HEXAFLUORIDE PRODUCTION PLANT. Environmental Report, Revised, November 1971. (Kerr-McGee Corp., Oklahoma City, Okla.). 24 Nov 1971. 66p. Dep. NTIS.

The revised environmental report includes discussions of site and area, environmental approval, environmental impact, the environmental surveillance program, results of plant use, alternatives, commitments of resources, and cost benefit analysis. (M.C.G.)

6533 (SRARI-104) AMERICIUM, CURIUM, AND PROMETHIUM COMPLEXING WITH 1,2-DIAMINOCYCLOHEXANTETRAACETIC ACID. Elesin, A. A.; Zaitsev, A. A. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1971. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

The composition and stability constants of americium, curium, and promethium ion complexes are defined by the ion exchange method on KY-2 cationite with 1,2-diaminocyclohexanetetraacetic acid (1,2-DACTA). As 0.00IM solutions of 1,2-DACTA were used during investigations with their insignificant buffer capacity, α-oxyisobutyrate of ammonium was applied for the system buffering. In previous works it was shown that in these systems the process is determined by a complexon. It was also established that with 1,2-DACTA Am, C, and Pm form complexes of $[MA]^-$ structure, where $M = Am^{3+}$, Cm^{3+}, and Pm^{3+}, and A^{4-} is 1,2-DACTA anion the stability constant logarithms of which being 18.79, 18.96, and 18.50, respectively, at ionic strength of 0.1. It was shown as well that Am and Cm stability constants differ by a factor of 1.5. (auth)

6534 (UCRL-20426, pp 264-70) CHEMICAL ENGINEERING. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1971.

From Nuclear chemistry.

Research progress is reported in the following areas: rate of reaction of gaseous nitrogen oxides with water, behavior of Chlorella pyrenoidosa in steady-state continuous culture; and optical isomer separations through stereospecific molecular interactions. (D.H.M.)

6535 PREPARATION AND PROPERTIES OF Cr_2UO_6. Hoekstra, Henry R.; Siegel, Stanley (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem.; 33: No. 9, 2867-73(Sep 1971).

Cr_2UO_6 was prepared hydrothermally by the reaction of uranium trioxide with a chromium(III) nitrate solution at 325 to 425°C. The crystal symmetry is hexagonal, space group $D^{1}_{3d}-P\bar{3}1m$, with a = 4.988[1] and c = 4.620[1] Å. The ir spectrum is shown to be in accord with predictions of factor group analysis. Thermal analysis indicates that Cr_2UO_6 is stable in air to 950°C. (auth)

6536 PREPARATION AND PROPERTIES OF TRIINDENYLTHORIUM CHLORIDE AND TRIINDENYLURANIUM CHLORIDE. Laubereau, P. G.; Ganguly, L.; Burns, J. H.; (and others) (Oak Ridge National Lab., Tenn.). Inorg. Chem.; 10: No. 10, 2274-80(Oct 1971).

The syntheses of $Th(C_9H_7)_3Cl$ and $U(C_9H_7)_3Cl$ are reported. Evidence is given for the existence of $Th(C_9H_7)_4$, $U(C_9H_7)_4$, $Th(C_9H_7)_2Cl_2$, and $U(C_9H_7)_2Cl_2$. Some properties of the triindenylactinide halide complexes are described. Mass spectra, NMR spectra, infrared spectra, and electronic spectra are given and discussed together with x-ray powder diagrams and results from x-ray single-crystal data obtained with the precession method. $Th(C_9H_7)_3Cl$ and $U(C_9H_7)_3Cl$ are isomorphous. Evidence is given for the presence of metal to indenyl ligand bonds with the C_5-ring parts of the ligands centrally bonded to the metals. The indenyl to uranium bonds seem to be more covalent in character than the indenyl to thorium bond. (auth)

6537 STABILITY OF PENTAVALENT PLUTONIUM. Silver, G. L. (Monsanto Research Corp., Miamisburg, Ohio). Contract AT(33-1)-GEN-53. Radiochem. Radioanal. Lett.; 7: No. 4, 213-16(15 Aug 1971).

A method for estimating the acidity of maximum stability of pentavalent plutonium in acid solutions is presented. The method predicts acidities within a narrow pH range are equally acceptable for the preparation of solutions in which the equilibrium concentration of pentavalent plutonium is maximized. With the aid of this method, the prediction is made that no acidity can be found in which solutions of pure, unsequestered pentavalent plutonium will be permanently stable. (auth)

6538 PREPARATION AND IDENTIFICATION OF COMPOUNDS OF HEPTAVALENT PLUTONIUM. Pages, M. (Institut du Radium, Paris); Nectoux, F.; Freundlich, W. Radiochem. Radioanal. Lett.; 8: No. 3, 147-50(10 Nov 1971). (In French).

Compounds of heptavalent plutonium ($M(I)_3Pu(VII)O_5$) were prepared at 250°C by direct reaction between PuO_2 and the alkaline superoxides RbO_2 and CsO_2. The phases obtained are isostructural with respect to one another and with the corresponding neptunium phases. Their thermal decomposition yields a tetragonal phase of plutonium(VI)($M_2Pu(VI)O_4$), isostructural with $M_2Np(VI)O_4$. (auth)

6539 REACTIONS OF HOT H WITH C_2D_4. Penzhorn, R. D.; Darwent, B. deB. (Catholic Univ. of America, Washington, D. C.). J. Chem. Phys.; 55: No. 8, 4148-9(15 Oct 1971).

Various mixtures of H_2S and C_2D_4 were photolyzed. The uncondensable gaseous products were measured and the HD/H_2 ratio determined mass spectrometrically. (M.C.G.)

6540 CHEMICAL BEHAVIOR OF BINUCLEAR OXYGEN-BRIDGED NITRATONITROSYLRUTHENIUM COMPLEX IN AN AQUEOUS ENVIRONMENT. Ishiyama, Toshio; Matsumura, Takashi. Annu. Rep. Radiat. Center Osaka Prefect.; 11: 50-2 (1970).

The chemical behavior of binuclear oxygen-bridged nitratonitrosylruthenium complex was studied in neutral aqueous solution containing sodium nitrate. This binuclear complex has been referred to for convenience as (Ru-O-Ru)-nitrate, and is formed in reactor fuel-reprocessing through solvent extraction. It was found that nitrosyl groups of the original binuclear complex change to nitro or nitrato group by air oxidation, and charge-negative mononuclear aquo-ruthenyl complex is formed, presumably due to the decomposition and air-oxidation of (Ru-O-Ru)nitrate. (auth)

6541 FORMATION AND FLUORINATION OF LITHIUM FLUOROPLUTONATE(IV) COMPOUNDS. Trevorrow, L. E.; Riha, J. G.; Steindler, M. J. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem.; 33: No. 9, 2875-82(Sep 1971).

At 300°C, the solid product of the reaction of $PuF_6(g)$ with $LiF(s)$ was found to be $LiPuF_5$. At 350 to 450°C, the solid product of the reaction of $LiPuF_5(s)$ with $F_2(g)$ was found to be Li_4PuF_8, and the solid product of the reaction of $Li_4PuF_8(s)$ with $F_2(g)$ was found to be LiF. These experimental observations were used to infer that the reaction of PuF_6 with LiF can be expected to produce a number of solid complexes that are analogues of the compounds known to exist in the condensed system $LiF-UF_4$. Activation energies for the rates of reaction of $LiPuF_5$ and Li_4PuF_8 with fluorine (1 atm) were found to be 12 and 10 kcal/mole PuF_4, respectively. Fluorinations of the complexes proceeded with a first-order dependence on fluorine pressure in the range from 0.3 to 1 atm. The fluorination results also limited the value of the equilibrium constant, p_{F_2}/p_{PuF_6}, for the reaction $4LiF(s) + PuF_6(g) \rightleftharpoons Li_4PuF_8(s) + F_2(g)$ at 400°C between 1×10^3 and 16×10^3. (auth) (UK)

6542 FLUORESCENT COMPOUND OF TANTALUM WITH MORIN. Pilipenko, A. T.; Vol'kova, A. I.; Zhebentyaev, A. I. (Inst. of General and Inorganic Chemistry, Kiev). Ukr. Khim. Zh.; 37: No. 6, 578-81(Jun 1971). (In Russian).

A new fluorescing compound of Ta, morin, and H_2O_2 was studied, which is unstable in aqueous solutions as a result of the catalytic activity of Ta on the oxidation of morin. Extraction with butyl alcohol gave solutions of the Ta complex whose fluorescence was stable for 30 to 40 min. The optimum conditions for forming the Ta complex were: a pH of 3, a 1:1 ratio of Ta and morin, wave length at maximum fluorescence = 510 nm, spectrophotometric band at 410 to 420 nm. The luminescent quantum yield was 22.7% and the molar coefficient of absorption at 436 nm was 2.5×10^3 for butanol solutions of the Ta complex. (tr-auth)

6543 APPLICATION OF FORCED-FLOW LIQUID CHROMATOGRAPHY TO THE DETERMINATION OF IRON. Seymour, Mark D.; Sickafoose, John P.; Fritz, James S. (Iowa State Univ., Ames). Anal. Chem.; 43: No. 13, 1734-7(Nov 1971).

A liquid chromatograph is described that permits rapid separation of metal ions using strongly acidic eluents. The chromatograph is inexpensive to construct and provides for quick changing of eluents. With this equipment, iron(III) can be separated from other ions and determined spectrophotometrically in less than 6 minutes. The iron is concentrated on a small anion exchange column and then is stripped from the column with dilute hydrochloric acid. The amount of iron is calculated from the peak height of the elution curve. Of 65 ions tested, only Ru(III), Mo(VI), U(VI), Pd(II), and Bi(III) were found to interfere. (auth)

6544 SPECTROPHOTOMETRIC DETERMINATION OF BISMUTH IN IRON PRODUCTS. Borlera, Maria Lucco. Atti Accad. Sci. Torino, I. Cl. Sci. Fis., Mat. Natur.; 105: No. 3, 439-52(May-Jun 1971). (In Italian).

A method is proposed for the determination of Bi in iron alloys. It is based on the spectral absorption at 530 mμ of an acid solution ($HClO_4$) containing 0.01% of Xylenol Orange, with the prior extraction of Fe and Sb with isobutyl acetate. Amounts of Bi from 10 to 300 μg can be determined, which is equivalent in samples from 0.1 to 0.5 g to Bi percentages in the alloy between 0.002 and

0.2. The effects of other elements, including U, Mo, Ta, Nb, Zr, and Th, on the determination were studied. (tr-auth)

6545 ACTIVITY OF WATER AND ELECTROLYTES IN CONCENTRATED ELECTROLYTE SOLUTIONS. Kalman, E. (Technische Univ., Dresden). Z. Phys. Chem. (Leipzig); 245: No. 5-6, 431-5(1970). (In German).

The activities for water and electrolytes were measured in concentrated solutions of various electrolytes. It was concluded that ions such as $Al(ClO_4)_3$ substitute one H_2O molecule in the water structure. This substitution type of ions creates a spherical configuration. Uranyl ions, on the other hand, form linear structures that infiltrate channel-like spaces in the water structure. The structuring of water through the uranyl ion can be conceived as a solid liquid. (H.B.G.)

6546 EVALUATION OF EQUILIBRIUM CONSTANTS OF U(IV)–U(VI) ELECTRON EXCHANGE REACTIONS FROM ISOTOPE SHIFTS OF SOME URANYL CHLORO COMPLEXES MEASURED BY I.R. SPECTRA. Gonda, K.; Satoh, H. (Power Reactor and Nuclear Fuel Development Corp., Tokai, Japan). J. Inorg. Nucl. Chem.; 33: No. 9, 2997-3000(Sep 1971).

The isotope shifts of the uranyl chloro complexes on tributyl phosphate, tri-n-octylamine, an anion exchange resin, Dowex 2 × 10 and 8.4 M HCl were measured by the infrared spectra in the 970 to 865 cm^{-1} region. The equilibrium constants of the U(IV)–U(VI) electron exchange reactions were calculated from the isotope shifts measured and compared with the equilibrium constants which were estimated from the isotopes separation effects in tri butyl phosphate, tri-n-octylamine, Dowex 2 × 10 and 8.4 M HCl systems. (auth)

Isotope Effects and Exchange

Refer also to abstracts 6606 and 6721.

6547 PHOSPHINOTRIHYDROBORATE(1–), $H_2P.BH_3^-$, THE CONJUGATE BROENSTED BASE OF PHOSPHINE–BORANE. SYNTHESIS, REACTIONS, AND STABILITY OF THE LITHIUM SALT. Mayer, Erwin (Univ., Innsbruck). Inorg. Chem.; 10: No. 10, 2259-62(Oct 1971).

Phosphine–borane reacts with n-butyllithium to form $(H_2P \cdot BH_3)Li$. This compound is soluble in aprotic solvents and is extremely reactive toward moisture. Proton NMR, infrared, and Raman data are presented and analyzed in terms of C_s symmetry for the anion. The thermal stability points to an increase in B–P bond strength compared with the B–P bond in $H_3P \cdot BH_3$. $(H_2P \cdot BH_3)Li$ behaves as a Lewis base and reacts with diborane to form $(H_2P(BH_3)_2)Li$. $(H_2P \cdot BH_3)Li$ dissolved in CD_3CN exchanges its PH_2 protons for deuterium, whereas no exchange occurs in $(H_2P(BH_3)_2)Li-CD_3CN$ solutions. This is analogous to the kinetics of exchange in hypophosphorous acid and in phosphoric acid where a conversion into a tautomeric form with tricoordinated phosphorus has been postulated as the rate-determining step. (auth)

6548 PHOSPHORUS–PHOSPHORUS BOND. III. THE MICROWAVE SPECTRUM, CONFORMATION, AND DIPOLE MOMENT OF PHOSPHINODIFLUOROPHOSPHINE. Kuczkowski, R. L.; Schiller, H. W.; Rudolph, R. W. (Univ. of Michigan, Ann Arbor). Inorg. Chem.; 10: No. 11, 2505-8(Nov 1971).

The rotational spectrum of phosphinodifluorophosphine was assigned with the following rotational constants (MHz): A = 6916.53, B = 3372.94, C = 2648.59 for H_2PPF_2; A = 6625.56, B = 3192.44, C = 2522.37 for D_2PPF_2. The dipole moment was measured as 1.71 ± 0.01 D, with principal axes components $\mu_a = 1.25$ D and $\mu_c = 1.16$ D. From the rotational constants and dipole moment data, the conformation was determined as trans. With the assumption that d(PH) = 1.42 ± 0.01 Å, the following structural parameters were derived: d(PP) = 2.218 ∓ 0.038 Å, d(PF) = 1.587 ± 0.013 Å, ∠ HPH = 93.2 ∓ 1.0°, ∠ HPP = 90.3 ∓ 0.4°, ∠ FPF = 98.2 ∓ 1.2°, and ∠ FPP = 97.2 ± 1.6°. (auth)

6549 VIBRATIONAL SPECTRA AND ASSIGNMENTS FOR ISOTOPIC SPECIES OF TETRABORANE(10). Dahl, Alton Joe; Taylor, Robert Cooper (Univ. of Michigan, Ann Arbor). Inorg. Chem.; 10: No. 11, 2508-15(Nov 1971).

Four isotopically enriched species of tetraborane(10) were prepared involving hydrogen, deuterium, boron-10, and boron-11. The infrared spectra of these compounds were investigated in the gas and solid states in the spectral region from 400 to 4000 cm^{-1}. Low-resolution Raman spectra in the liquid and solid states were obtained and qualitative polarization measurements made. Vibrational modes of this molecule are described on the basis of a symmetry analysis and a group vibration approximation. Tentative vibrational assignments were made for 34 of the 36 fundamentals. (auth)

6550 MECHANISM OF CONTACT ELIMINATION, A CONTRIBUTION TO UNDERSTANDING THE FUNCTION OF POLAR CATALYSTS. Noller, Heinrich (Technische Hochschule, Vienna); Andreu, Paulino; Hunger, Manfred. Angew. Chem. Int. Ed. Engl.; 10: No. 3, 172-81(Mar 1971).

Current ideas of organic chemists based on the work of Ingold are applied to heterogeneous catalytic eliminations (mostly from haloalkanes and aliphatic alcohols). It was deduced from the activity of the catalysts, the reactivity of the substrates (reactants), and the primary product distribution that these eliminations proceed by a heterolytic mechanism similar to that involved in the liquid phase. The activity of the catalysts (salts and oxides) increases with increasing charge and decreasing radius of the cations and with increasing basicity of the anions. The reactivity of the substrates behaves in much the same manner as in the liquid phase. In contrast with the liquid-phase reaction, the cis-olefins are frequently favored as primary products. The stereospecificity of the reaction is determined from the relative strengths of the interactions between the catalyst cation and the leaving group X^-, and between the catalyst anion and the leaving proton. Only trans elimination has so far been found in the concerned mechanism. Kinetic isotope effects on the catalytic reaction were considered. (auth)

6551 EFFECT OF P–H DEUTERIUM SUBSTITUTION ON THE ^{31}P NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY OF SEVERAL DIALKYL PHOSPHONATES. Stec, Wojciech J.; Goddard, Nicholas; Van Wazer, John R. (Vanderbilt Univ., Nashville). J. Phys. Chem.; 75: No. 23, 3547-9(11 Nov 1971).

By means of ^{31}P nuclear magnetic resonance spectroscopy, the coupling constants and chemical shifts were measured for various dialkyl phosphonates in which the hydrogen bonded to the phosphorus is present as either the normal isotope or deuterium. It is seen that the ratio of the coupling constants $^1J_{PH}/^1J_{PD}$ as well as the isotope shift undergo small but apparently real variations, particularly upon going to a hydrogen-bonding solvent. These variations are ascribed to a difference in hydrogen-bonding capability of the deuterated and nondeuterated species. (auth)

6552 LOW-MAGNITUDE, PURE-PRIMARY, HYDROGEN KINETIC ISOTOPE EFFECTS. Stern, Marvin J.; Schneider, Mary E.; Vogel, P. Christian (Yeshiva Univ., New York). J. Chem. Phys.; 55: No. 9, 4286-90(1 Nov 1971).

It is shown theoretically that low-magnitude, primary, hydrogen kinetic isotope effects may be characterized by the same types of temperature-dependence irregularities that have been previously shown to be expected fairly commonly for secondary hydrogen isotope effects and primary heavy-atom isotope effects. Upper limits are given for the magnitudes of pure-primary and mixed-primary–secondary hydrogen kinetic isotope effects possibly associated with such temperature-dependence "anomalies." (auth)

6553 AVERAGE STRUCTURES OF t-BUTYL CHLORIDE AND 9D-t-BUTYL CHLORIDE DETERMINED BY GAS-PHASE ELECTRON DIFFRACTION. Hilderbrandt, R. L.; Wieser, J. D. (Indiana Univ., Bloomington). J. Chem. Phys.; 55: No. 9, 4648-54(1 Nov 1971).

The structure of t-butyl chloride has been determined by electron diffraction. The results obtained are in good agreement with the previous structure determination by Momany, Bonham, and Druelinger. This structure is shown to be consistent with the microwave rotational constants determined by Lide and Jen in spite of the fact that the r_g distance for the C–Cl bond (1.828 ± 0.005 Å) is quite different from the r_s microwave distance (1.803 ± 0.002 Å). The remaining structural parameters were determined to be C–C (1.528 Å), C–H (1.102 Å), ∠ClCC (107.3°), ∠CCH (110.8°), ∠CCC (111.6°), and ∠HCH (108.1°). A simultaneous investigation of the structure of the deuterated species suggests slight secondary isotope effects on the C–C (ΔC–C = 0.0010 ± 0.0007-Å) and C–Cl (ΔC–Cl = 0.0010 ± 0.0015-Å) distances. Observed mean amplitudes of vibration are found to be consistent with values calculated from the harmonic force field of Hüttner and Zeil. (auth)

6554 REACTION ORDERS AND ISOTOPE EFFECTS IN THE REVERSIBLE ADDITION OF WATER TO 1,3-DICHLOROACETONE IN AQUEOUS DIOXAN. Bell, R. P.; Critchlow, J. E. (Univ. of Stirling, Scotland). Proc. Roy. Soc. (London), Ser. A; 325: No. 1560, 35-55(5 Oct 1971).

The kinetics of the reversible addition of water to 1,3-dichloroacetone were studied spectrophotometrically in aqueous dioxan with and without the addition of catalysts (hydrogen chloride, perchloric acid, four carboxylic acids, and 2,6-dichlorophenol). Reaction orders with respect to water were determined, and also kinetic isotope effects in systems containing 50 and 100 atom % of deuterium. It is concluded that the uncatalyzed reaction involves a cyclic transition state containing two extra water molecules, one of which may be replaced by a molecule of catalyst. The dependence of the kinetic orders and isotope effects upon the nature of the catalyst is attributed mainly to differences in the hydration or other properties of the catalyst in the initial state. It is believed that proton movement is partly synchronous with the making or breaking of the carbon—oxygen bonds, but there is no evidence that more than one proton moves simultaneously. (auth)

6555 NORMAL COORDINATE ANALYSIS AND INTENSITY CALCULATIONS FOR $^1A'$ AND $^1A''$ ELECTRONIC STATES OF PROPYNAL. Williams, Denis R. (Univ. of Colorado, Denver). J. Chem. Phys.; 55: No. 9, 4578-86(1 Nov 1971).

A normal coordinate analysis using a quadratic force field is carried out for the ground and first-excited singlet electronic states of the molecules $HC\equiv C \cdot CHO$, $DC\equiv C \cdot CHO$, $HC\equiv C \cdot CDO$. Three force constant matrix elements are transferred from ground to excited states. The normal coordinates enable the intensities of a number of transitions to be calculated and favorably compared to those observed. The agreement between calculated and observed frequencies is excellent for all isotopes. Semiempirical SCF MO theory (CNDO/2) is used to correlate the changes of geometry and electronic structure on excitation as well as to account for the remaining observed electronic bands of propynal. (auth)

6556 DETERMINATION OF RATE CONSTANTS FOR REACTIONS OF O ATOMS WITH C_2H_2, C_2D_2, C_2H_4, AND C_3H_6 USING A PULSED VACUUM-UV PHOTOLYSIS—CHEMILUMINESCENT METHOD. Stuhl, F.; Niki, H. (Ford Motor Co., Dearborn, Mich.). J. Chem. Phys.; 55: No. 8, 3954-7(15 Oct 1971).

Absolute rate constants for the primary reactions of O atoms with C_2H_2, C_2D_2, C_2H_4, and C_3H_6 were determined using vacuum-uv flash photolysis of NO to produce the O atoms. Decays of O atoms were monitored by NO_2^* chemiluminescent emission with initial O-atom concentrations in the range 1 to 5×10^{10} atoms cm^{-3}. The rate constants obtained at 300°K are (in units of cubic centimeters $molecule^{-1} \cdot second^{-1}$): $k = 1.31 \times 10^{-13}$ (+5; –10%), for $O + C_2H_2$ and $O + C_2D_2$; $k = 6.3 \times 10^{-13}$ (+5; –15%), for $O + C_2H_4$; $k = 3.6 \times 10^{-12}$ (+5; –10%), for $O + C_3H_6$. The parameters involved in the assignment of the error limits are discussed in detail. (auth)

6557 DETERMINATION OF VARIOUS HYDROGEN—DEUTERIUM ISOTOPE EFFECTS IN CARBANION REACTIONS USING ELECTRON TRANSFER AS A REFERENCE REACTION. Guthrie, Robert D.; Young, A. T.; Pendygraft, G. W. (Univ. of Kentucky, Lexington). J. Amer. Chem. Soc.; 93: No. 19, 4947-8(22 Sep 1971).

A convenient method for measuring isotope effects on carbanion protonation at steady-state concentrations is reported and some general conclusions are drawn regarding such reactions. The primary isotope effect for proton removal by the carbanion from solvent molecules was calculated based on rate constants for exchange and loss of 9-methoxyfluorene catalyzed by potassium methoxide in methanol and deuterated methanol. (D.H.M.)

6558 TRANSCARBOXYLATION REACTIONS OF MIXTURES OF DEUTERIUM-LABELED AND UNLABELED SALTS OF CARBOXYLIC ACIDS WITH VARIOUS AROMATIC RINGS. Ratusky, J. (Inst. of Organic Chemistry and Biochemistry, Prague). J. Radioanal. Chem.; 8: No. 1, 107-15(Jun 1971).

The exchange of deuterium for protium in aromatic rings during the transcarboxylation reactions of mixtures of salts of aromatic carboxylic acids is possible even between acids with different aromatic rings. This exchange takes place exclusively when the transcarboxylation reaction proceeds simultaneously because only the latter reaction gives rise to carbanions, which are the necessary prerequisites of transprotonization. (M.C.G.)

6559 KINETICS OF THE EXCHANGE OF IODINE BETWEEN o-IODOHIPPURIC ACID AND POTASSIUM IODIDE IN AQUEOUS SOLUTION. Yeh, Si-jung; Chen, Ching-tan; Chiou, Koun-yen (National Tsing Hua Univ., Taiwan). Nucl. Sci. J. (Taiwan); 8: No. 1, 12-20(Apr 1971).

The kinetics of ^{131}I exchange between o-iodohippuric acid and potassium iodide in aqueous solution was studied at various temperatures and concentrations. Meschan's technique for the estimation of radioiodide contamination in water-soluble, carbon tetrachloride-insoluble radioiodinated organic compounds was employed as the separation procedure. The results showed that the rate of the exchange reaction is first order with respect to the o-iodohippuric acid concentrations. The activation energy and rate constant for the reaction were determined. Data of the kinetic study are discussed in connection with the routine preparation of ^{131}I-labeled hippuran. (auth)

6560 KINETIC APPLICATIONS OF ELECTRON PARAMAGNETIC RESONANCE SPECTROSCOPY. III. SELF-REACTIONS OF DIALKYL NITROXIDE RADICALS. Bowman, D. F.; Gillan, T.; Ingold, K. U. (National Research Council of Canada, Ottawa). J. Amer. Chem. Soc.; 93: No. 24, 6555-61(1 Dec 1971).

Bimolecular rate constants and activation parameters were measured for the self-reactions of several dialkyl nitroxides in a number of solvents. It has been shown that there is a large deuterium isotope effect on the reaction if the hydrogens on the α-carbons are replaced by deuterium. The results are consistent with a mechanism involving the reversible formation of a diamagnetic nitroxide dimer and its slow decomposition to a hydroxylamine and a nitrone. The equilibrium constant for dimer formation has been determined with $(CH_3CD_2)_2NO\cdot$ in isopentane and in CF_2Cl_2. The analogy between the self-reactions of nitroxides and of peroxy radicals is pointed out. (auth)

6561 KINETICS AND MECHANISM OF HYDROGEN—DEUTERIUM EXCHANGE IN THE METHYL GROUPS OF PYRIDINES IN DILUTE AQUEOUS ACID. FACTORS INFLUENCING THE DEGREE OF CATALYSIS. Zoltewicz, John A.; Kandetzki, Paul E. (Univ. of Florida, Gainesville). J. Amer. Chem. Soc.; 93: No. 24, 6562-7(1 Dec 1971).

Rates of hydrogen—deuterium exchange in the methyl groups of 2-methyl-(II), 2,6-dimethyl-(III), and 2,6-dimethyl-4-aminopyridine (IV) in D_2O and D_2O-DCl at 164.6° were obtained by an NMR method. Substrates acted as buffers to control solution acidity. Evidence is presented for a mechanism involving specific acid general base catalysis (kinetically equivalent to general acid catalysis). The conjugate acid of substrate is deprotonated at carbon by base. Exchange reactions of II and III are catalyzed by substrate acting as a base and by deuteroxide ion but IV shows deuteroxide ion catalysis only. A discussion of the factors influencing the relative amounts of substrate (general base) and deuteroxide ion catalysis is presented. (auth)

6562 REACTIONS OF DIHYDRONICOTINAMIDES. I. EVIDENCE FOR AN INTERMEDIATE IN THE REDUCTION OF TRIFLUOROACETOPHENONE BY 1-SUBSTITUTED DIHYDRONICOTINAMIDES. Steffens, James J.; Chipman, David M. (Massachusetts Inst. of Tech., Cambridge). J. Amer. Chem. Soc.; 93: No. 24, 6694-6(1 Dec 1971).

Evidence is presented that requires that one particular "hydride transfer," the reduction of trifluoroacetophenone to trifluoromethylphenylcarbinol by some 1-substituted-1,4-dihydronicotinamides, be a two-step process. The isotope effect obtained for n-propyl-1, 4-dihydronicotinamide is 1.38 ± 0.11; for benzyl-1,4-dihydronicotinamide it is 2.77 ± 0.85; and for 2,6-dichlorobenzyl-1,4-dihydronicotinamide it is 5.25 ± 0.56. (D.H.M.)

6563 HOMOPOLYMERIZATION SUPPRESSION BY MEANS OF RADIO-CHEMICAL GRAFTING IN THE VAPOR PHASE. Tikhomirov, V. S.; Deev, Yu. S.; Serenkov, V. I. Vysokomol. Soedin., Ser. B; 13: No. 4, 256-7(Apr 1971). (In Russian).

Unstabilized polyethylene film 200 μ thick was exposed to ^{60}Co gamma radiation at a dose rate of 70 rad/sec at 25°C in the presence of vinyl chloride at a pressure of 600 mm. The extent of grafting was determined by weighing after an extraction with cyclohexane, and proved to be proportional to the radiation dose. The "effectiveness" of the process was increased from 45 to 100% by the presence of an electric field whose intensity was 1 kV/cm. (K.S.W.)

6564 EFFECT OF ADSORPTION POTENTIAL ON THE HYDROGEN—DEUTERIUM EXCHANGE OF BENZENE AT A FUEL CELL ELECTRODE. Barger, H. J. Jr.; Coleman, A. J. (Army Mobility Equipment Research and Development Center, Fort Belvoir, Va.). J. Phys. Chem.; 75: No. 24, 3715-19(25 Nov 1971).

The effect of adsorption potential on the hydrogen—deuterium exchange of benzene at a fuel cell electrode was studied using 85% D_3PO_4 as the electrolyte. The exchange was monitored by continuously passing the effluent from an electrochemical cell into the ionization chamber of a mass spectrometer. The amount of exchange that occurred varied markedly with potential, increasing as the potential was lowered from 0.45 to 0.20 V vs the dynamic hydrogen electrode. The isotopic distribution of the deuteriobenzenes differed with changing potential in such a way that two types of reactions were suggested, one involving stepwise exchange and the other multiple exchange. (auth)

6565 ISOTOPE EFFECTS IN RADICAL REACTIONS OF PHENOL INHIBITORS. Simonyi, M.; Tuedoes, F.; Pospisil, J.; Holly, S. (Central Research Inst. for Chemistry, Budapest). pp 125-7 of Kinetics and Mechanism of Polyreactions. Vol. III. Budapest; Akademiai Kiado (1969).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843—(Vol.3).

The stabilizing effect of phenols is connected with the homolytic splitting ability of the O−H bond; the first reaction is $Ar{\cdot}OH + R\cdot \rightarrow ArO\cdot + H{\cdot}R$, where R· is a reactive radical. The variation of the kinetic isotope effect k_H/k_D in vinyl acetate is described by a Hammett-type equation $\log k_H/k_D = 0.70 - 0.40\ \Sigma\sigma^+$. The limits and deviations from linearity of the equation are discussed. The effects of intermolecular interactions in polar media are considered, and equations are derived for the kinetic isotope effect. The variation in the factors of the equation is considered. (D.L.C.)

6566 STUDY OF THE ROTATION SPECTRA OF THE FORMIC ACID MOLECULE. B. STUDY OF SOME ISOTOPIC SUBSTITUTIONS. APPLICATION TO THE DETERMINATION OF THE STRUCTURE OF THE MOLECULE. Bellet, J. (Faculte des Sciences, Lille); Deldalle, A.; Samson, C.; Steenbeckeliers, G.; Wertheimer, R. J. Mol. Struct.; 9: No. 1-2, 65-75 (Jul 1971). (In French).

A number of transitions, pertaining to the isotopic species $D^{12}C^{16}O^{16}OD$, $H^{12}C^{16}O^{16}OD$, $D^{12}C^{16}O^{16}OH$, and $H^{13}C^{16}O^{16}OH$, of the formic acid molecule were assigned and measured. A determination of the rotational constants of the various molecules is given. In the case of $D^{12}C^{16}O^{16}OD$, there are enough experimental results to use the theory of Watson (2nd order). In the other cases the theory of Kivelson (1st order) is employed. A determination of the r_s structure of the molecule is proposed. (auth)

6567 LOW-TEMPERATURE INFRARED STUDIES. VIII. FERROELECTRIC AMMONIUM HYDROGEN SULPHATE AND AMMONIUM d_4-DEUTERIUM SULPHATE. Schutte, C. J. H.; Van Rensburg, D. J. J. (Univ. of South Africa, Pretoria). J. Mol. Struct.; 9: No. 1-2, 77-90(Jul 1971).

The temperature-dependence of the infrared spectra of NH_4HSO_4 and ND_4DSO_4 in the temperature range 285 to 17°K was determined. Vibrational assignments were made and correlated with predicted site- and factor-group theory. Discontinuities in bandheight versus temperature plots were found at 68 to 73, 92 to 105, 150 to 175, 210 to 215, and 255 to 275°K for NH_4HSO_4 and 65 to 70, 115 to 120, 160 to 172, and 275 to 290°K for ND_4DSO_4. These discontinuities are discussed and correlated with existing data. The discontinuity at 210 to 215°K is an additional phase change not previously reported. Because of the fact that the ferroelectric phase is intermediate between a high- and a low-temperature phase, changes in the infrared spectra due to ferroelectric or low-temperature effects could be distinguished. The ferroelectric phase is discussed in terms of hydrogen bonding. The temperature dependence of the OH torsional vibration within the ferroelectric region gave some indication as to the nature and cause of the ferroelectric behavior. A NMR linewidth transition is predicted at 68 to 73°K. (auth)

6568 EFFECT OF D_2O ON LUMINESCENCE OF TRYPTOPHAN DERIVATIVES AT ROOM TEMPERATURE AND AT 77°K. Busel, E. P.; Burshtein, E. A. (Inst. of Biological Physics, Pushchino, USSR). Biophysics (USSR) (Engl. Transl.); 15: No. 6, 1027-35(1970).

Translated from Biofizika; 15: No. 6, 993-1000(1970).

The effect of replacing H_2O by D_2O on the luminescence spectra of solutions of tryptophan, indole, their derivatives and various ionic forms at room and low (77°K) temperatures was studied. At room temperature for all the derivatives investigated, replacement of H_2O by D_2O led to increase in the yield of fluorescence without significant change in the form and position of the spectra; the absorption spectra practically did not change. The reciprocals of the quantum yield changed linearly with rise in the concentration of D_2O. Experiments in 95% proton-free solvent (dioxane) showed that in all cases the effect was due to deuterization of water. Only in two cases (tryptophan and alanyltryptophan) did deuterization of the side-chain amino groups make a contribution to the total effect. Addition to the solution of salts considerably lessened the effect of D_2O without an appreciable influence on the fluorescent yield in H_2O. This effect is probably connected with the influence of the salts on the processes of non-radiation deactivation of the excited singlet state sensitive and insensitive to deuterization. No changes in the yield of fluorescence were observed (within the limits of accuracy of the experiment) at 77°K by replacement of H_2O with D_2O. The ratios of the yields of phosphorescence and fluorescence like the lifetime of phosphorescence for all the derivatives increased by ~10%, which is interpreted as the result of the uniform fall in the rate constant of the non-radiation transition $T \rightsquigarrow S_0$ in D_2O in the absence of an effect on the probability of the intercombination conversion $S_1 \rightsquigarrow T$. Analysis of the results indicates that replacement of H_2O by D_2O influences the probability of the process of non-radiation deactivation $S_1 \rightsquigarrow S_0$. It is possible that such a process is the photochemical quenching of the reactions with transfer of a proton between the excited indole ring and the water molecule. (auth)

Physical Chemistry

Refer also to abstracts 7169 and 7181.

6569 (COO-716-72) INVESTIGATION OF SOME LANTHANIDE BORON, CARBON, NITROGEN SILICON, CHALCOGEN AND HALOGEN SYSTEMS AT ELEVATED TEMPERATURES. Technical Progress Report, February 1, 1971–January 31, 1972. Eick, Harry A. (Michigan State Univ., East Lansing. Dept. of Chemistry). Contract AT(11-1)-716. 38p. Dep. NTIS.

ERBIUM ALLOYS AND SYSTEMS— Er−F−Gd, phase studies in
EUROPIUM IODIDES— vaporization of EuI_2
EUROPIUM OXYCHLORIDES— vaporization of, incongruent
EUROPIUM OXYFLUORIDES— decomposition of, thermodynamics of
FLUORINE SYSTEMS— F−La−Nd, phase studies in
— Er−F−Gd, phase studies in
GADOLINIUM ALLOYS AND SYSTEMS— Er−F−Gd, phase studies in
LANTHANUM ALLOYS AND SYSTEMS— F−La−Nd, phase studies in
NEODYMIUM ALLOYS AND SYSTEMS— F−La−Nd, phase studies in
NEODYMIUM OXYBROMIDES— thermal decomposition of, thermodynamics of
THULIUM CARBIDES— crystal structure of TmC_2
YTTERBIUM CARBIDES— crystal structure of
ZINC FLUORIDES— vaporization of ZnF_2, thermodynamics of (TSS)

6570 (UCRL-20426, pp 226-36) X-RAY CRYSTALLOGRAPHY. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1971.

From Nuclear chemistry.

6571 (UCRL-20426, pp 236-58) PHYSICAL AND INORGANIC CHEMISTRY. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1971.

From Nuclear chemistry.

Research progress is reported in the following areas: trigonal californium trifluoride; preparation and determination of the crystal structures of californium and einsteinium metals; bis(cyclooctatetraenyl)neptunium(IV) and bis(cyclooctatetraenyl) plutonium; electron-probe microanalysis of pottery materials; an introductory study of Mycenaean IIIC1 ware from Tel Ashdod; chemical variations in obsidian; rapid, nondestructive method of fluorine analysis by ^3He activation; and anion exchange in aqueous-organic solvent mixtures. (D.H.M.)

6572 MOLECULAR STRUCTURE OF TETRACHLOROBIS-(HEXAMETHYLPHOSPHORAMIDE)URANIUM(IV). de Wet, J. F. (Univ. of Port Elizabeth, S. Afr.); Darlow, S. F. Inorg. Nucl. Chem. Lett.; 7: No. 10, 1041-8(Oct 1971).

It is stated that very little structural information has been published so far on the coordination chemistry of the actinides. The structural investigation reported was undertaken as part of a program to obtain the molecular parameters needed to place much of the interesting spectral, thermodynamic, and magnetochemical data into proper perspective. Interest in the very potent O-donor ligand hexamethylphosphoramide (HMPA) led to the choice of the extraordinarily stable $UCl_4 \cdot 2$ HMPA complex for crystallographic study. A complete x-ray structural determination was not achieved; two out of the six methyl carbons in the asymmetric unit could not be placed, but sufficient information was obtained to reveal the molecular structure in all essential details. The crystal data were: monoclinic, space group $P2_1/n$, cell dimensions $a = 14.15$ Å, $b = 10.53$ Å, $c = 9.08$ Å, 2 mols per unit cell. The molecule is centrosymmetric in the crystalline state, and four Cl-atoms surround each octahedrally coordinated U at the corners of a square. The two HMPA molecules are trans-octahedrally arranged around the central atom, and the very short U−O distance (2.24 Å) leads to a tetragonal contraction perpendicular to the plane of the Cl atoms. The U−O approach distance is consistent with the high donor strength of the ligand and implies that the bond possesses appreciable covalent character. (UK)

6573 URANIUM-OXYGEN LATTICE VIBRATIONS OF LITHIUM AND SODIUM URANATES. Ohwada, Ken (Japan Atomic Energy Research Inst., Ibaraki). Inorg. Chem.; 10: No. 10, 2281-5(Oct 1971).

Normal-coordinate treatment of the optically active U−O lattice vibrations of lithium uranate, Li_4UO_5, and sodium uranate, Na_4UO_5, has been reported previously on the assumption of a simple chain structure model of $(UO_5)_\infty$. Based on the results of this treatment, some of the observed frequencies have been assigned to the U−O lattice vibrations. The force constants concerning U−O bonds and angles have been obtained and discussed in some detail. The effect of Li–O and Na–O interactions on the U–O lattice vibrations has also been discussed in terms of their force constants estimated from Badger's relationship. (auth)

6574 CALCULATED SPECTROSCOPIC PARAMETERS AND THE INTERMEDIATE SPIN–ORBIT COUPLING DIAGRAM IN THE INTERPRETATION OF $5f^4$ $AmO_2{}^+$ SPECTRA. Varga, L. P. (Oklahoma State Univ., Stillwater); Mann, J. B.; Asprey, L. B.; Reisfeld, M. J. J. Chem. Phys.; 55: No. 9, 4230-7(1 Nov 1971).

Ab initio relativistic SCF Dirac–Fock and Dirac–Slater calculations of the free-ion Coulomb interaction parameter, F_2, and the spin–orbit coupling parameter, ζ, have been made for all known oxidation states of actinides, thorium through nobelium. These calculated parameters, when normalized to the experimental spectroscopic parameters, were used to initiate least-squares fits to nine experimental electronic energy levels of anhydrous $KAmO_2CO_3$, and to 15 levels of aqueous AmO_2^+ in 1M $DClO_4-D_2O$. Correlation with 35 lower levels of the f^4 intermediate spin–orbit coupling diagram allowed term assignments to be made to the experimental free-ion levels. Some differences in term assignments were noted between the solution and solid state spectra, but substantial agreement was found between the AmO_2^+ spectra taken in 1M $DClO_4-D_2O$ measured and some earlier AmO_2^+ spectra taken in 1M $HClO_4$. The "best" values for the spectroscopic parameters of $5f^4$ Am(V) were: $F_2 = 254$, $F_4 = 30.0$, $F_6 = 4.95$, and $\zeta = 2976$ cm^{-1}. The predicted trends for these parameters for the heavy actinides are discussed. (auth)

6575 FAR-INFRARED AND RAMAN SPECTRA OF HEXACHLORO SALTS OF TETRAVALENT NEPTUNIUM. Berringer, B. W. (Washington State Univ., Pullman); Gruber, J. B.; Loehr, T. M.; O'Leary, G. P. J. Chem. Phys.; 55: No. 9, 4608-12(1 Nov 1971).

The far-infrared and Raman spectra have been analyzed for the following compounds: dicesium neptunium hexachloride Cs_2NpCl_6, ditetramethylammonium neptunium hexachloride $[(CH_3)_4N]_2NpCl_6$, and ditetraethylammonium neptunium hexachloride $[(C_2H_5)_4N]_2NpCl_6$. Infrared studies on polycrystalline samples were carried out at room temperature and 98°K. Single-crystal Raman spectra were recorded at room temperature. Far-infrared absorption peaks were found as follows: Cs_2NpCl_6—265, 117, and 58 cm^{-1}; $[(CH_3)_4N]_2NpCl_6$—259, 116, and 65 cm^{-1}; and $[(C_2H_5)_4N]_2NpCl_6$—259, 117, and 59 cm^{-1}. Observed Raman spectra were found as follows: Cs_2NpCl_6—310 and 128 cm^{-1}; $[(C_2H_5)_4N]_2NpCl_6$—301 and 123 cm^{-1}. An interpretation of the observed spectra was made. The interaction force constants necessary to describe the observed spectrum are the Np-Cl stretch, K; the Cl-Np-Cl bend, H; the nonbonded Cl-Cl stretch, F; the interaction, k, between two Np-Cl stretches on opposite sides of the Np atom; and an angle–angle interaction, h, between angles at right angles to each other which share a common bond. The spectrum of the complex $NpCl_6^{-2}$ in each salt can be described by a given set of octahedral force constants, calculated using the Wilson FG matrix technique and a Urey–Bradley potential. The Cs_2NpCl_6 spectra are described by force constants K = 1.31 mdyn/Å, H = 0.053 mdyn/Å, F = 0.061 mdyn/Å, k = 0.40 mdyn/Å, and h = 0.015 mdyn/Å. The $[(CH_3)_4N]_2NpCl_6$ and $[(C_2H_5)_4N]_2NpCl_6$ salts can be described by the force constants K = 1.271 mdyn/Å, H = 0.053 mdyn/Å, F = 0.05 mdyn/Å, k = 0.38 mdyn/Å, and h = 0.015 mdyn/Å. The spectrum calculated using these parameters agrees to within 1% of the observed spectrum. (auth)

6576 MASS SPECTROMETRIC INVESTIGATION OF SURFACE IONIZATION. X. DESORPTION OF URANIUM IONS AND NEUTRALS FROM CARBURIZED RHENIUM. Smith, David H. (Oak Ridge National Lab., Tenn.). J. Chem. Phys.; 55: No. 8, 4152-4(15 Oct 1971).

Evaluation of the desorption parameters for uranium from carburized rhenium surfaces was undertaken prior to studies of the surface ionization of actinides on metals of high work function. The desorption energies were lower on carburized rhenium than on the pure polycrystalline metal and the desorption energy of the ions decreased by nearly twice as much as the desorption energy for the neutral species. This led to the prediction that carburized rhenium is a more efficient ionizer of uranium than the pure metal. (M.C.G.)

6577 LOW TEMPERATURE INFRARED AND RAMAN SPECTRA OF THE AMMONIUM HALIDES. Harvey, K. B.; McQuaker, N. R. (Univ. of British Columbia, Vancouver). J. Chem. Phys.; 55: No. 9, 4390-6(1 Nov 1971).

Using infrared and laser Raman techniques, the vibrational spectra of seven of the eight low-temperature phases of the ammonium and deuteroammonium halides (halide ion = Cl^-, Br^-, and I^-) have been recorded. More complete assignments than previously available have been made for the vibrations of crystalline NH_4^+ and ND_4^+ ions of T_d and D_{2d} symmetries. These include assignments for longitudinal components of infrared-active vibrations. Frequencies of acoustical translations are inferred by assigning combinations involving the $\nu_1(A_1)$ ammonium ion lattice vibrations and acoustical translations. (auth)

6578 PHYSICOCHEMICAL STUDY OF TITANIUM FILMS DEPOSITED ON COPPER AND OF SOME TITANIUM TARGETS. I. X-RAY OBSERVATION OF CHARACTERISTIC MODIFICATIONS IN THE COURSE OF THERMAL TREATMENTS. Peters, J. M.; del Fiore, G. (Univ., Liege). Radiochem. Radioanal. Lett.; 7: No. 4, 217-28(15 Aug 1971). (In French).

The examination of titanium and titanium hydride films deposited on copper backing (targets for neutron production), after thermal treatments in vacuum above 300°C, reveals anomalous x-ray patterns. The greatest unit cell of titanium on copper backing is compact hexagonal with the following dimensions: a = 2.98 Å, c = 4.86 Å, and c/a = 1.63 instead of a = 2.95 Å, c = 4.685 Å, and c/a = 1.59 for pure titanium. For titanium hydrides, the dimensions are: a = 4.52 Å (ccf) instead of a = 4.44 Å. The annealing of the hydride films modifies the x-ray patterns and reveals well known Cu–Ti phases as Cu_3Ti and $CuTi_2$. The existence of the successive phases can be interpreted by copper diffusion assumption, and from the backing into the deposited layer. (auth)

6579 CATALYSIS OF GRAPHITISATION. Marsh, H.; Warburton, A. P. (Univ. of Newcastle upon Tyne, Eng.). J. Appl. Chem. (London); 20: 133-42(May 1970).

The demand for graphites with specific properties and for an improvement in the economics of graphite production in recent years has led to an increased interest in catalytic graphitization. Mechanisms whereby inorganic additives can catalyze graphitization are considered, followed by a discussion of the mechanisms by which inorganic additives promote the graphitization process. A comprehensive survey of the relevant literature to date is presented, which describes in more detail the type of carbon used, the experimental techniques employed and the improvement obtained in graphite quality. (auth) (UK)

6580 SOME PROBABLE PHYSICO-CHEMICAL PROPERTIES OF ELEMENTS 104 TO 107. Haissinsky, M. (Laboratoire Curie, Paris). Radiochem. Radioanal. Lett.; 8: No. 2, 107-13(14 Oct 1971). (In French).

The ionic, metallic, and covalent radii, the ionization potentials and electronegativities of elements 104, 105, 106, and 107 are approximately evaluated by extrapolation. From the values obtained and from other relations known for the homologs, predictions are made concerning the probable, general physicochemical behavior of the first 4 elements that follow the 5f series. (auth)

6581 CHELATION OF SOME RADIONUCLIDES IN A SEAWATER MEDIUM. Fukai, Rinnosuke (International Lab. of Marine Radioactivity, Monaco). Rapp. Comm. Int. Mer. Mediter.; 19: No. 5, 935-6(1969).

Laboratory experiments were carried out in order to examine the possible direct chelate formation of some radionuclides with organic molecules in seawater medium. Realistic concentrations of metals were used and the time factor of the chelate formation was especially considered. The radionuclides used were ^{54}Mn, ^{60}Co, and ^{65}Zn. EDTA was used as a model of chelate-forming organic molecules. It was found that theoretical equilibria could not be reached within 100 hr in a relatively low range of metal concentrations. The results suggest that the process of chelate formation should be a slow process. It was concluded that the possibilities of the direct chelate formation of the radionuclides concerned with the organic molecules should be small in situ, since the uptake of the radionuclides by marine organisms, the sorption by suspended matter, etc., would prevail under the conditions in nature. (P.C.H.)

6582 PATHWAYS OF RADIATIVE AND RADIATIONLESS TRANSITIONS IN EUROPIUM(III) SOLUTIONS: ROLE OF SOLVENTS AND ANIONS. Haas, Yehuda; Stein, Gabriel (Hebrew Univ., Jerusalem). J. Phys. Chem.; 75: No. 24, 3668-77(25 Nov 1971).

Absorption and emission spectra of europium perchlorate and europium nitrate were measured in protonated and deuterated solvents (water, dimethyl sulfoxide, methanol, and acetonitrile). The line shape of these spectra is shown to depend strongly on the solvent and anion. Ion pairing takes place, depending on the combination of solvent and anion. Quantum yields and lifetimes of fluorescence from the $^5D_0$ level are reported. An isotopic enhancement factor of 40 is found in water, while in other solvents it is much smaller. The rate constants for radiative and radiationless processes are calculated. The radiationless constants range from about 10^4 sec^{-1} for light water to about 10 for deuterated dimethyl sulfoxide in which the fluorescent quantum yield on direct excitation to $^5D_0$ approaches unity. The suitability of this system for use as a liquid laser is indicated. It is shown that the anions also quench $^5D_0$ fluorescence. Radiationless rate constants for CNS^- and NO_3^- anions are calculated to be about 10^3 sec^{-1}. Fluorescence from the $^5D_1$ level is weak in all solvents. Its quantum yield is about 10^{-4} to 10^{-5}. The isotopic effect for this fluorescence is only 3. The probability for decay from the $^5D_1$ level directly to ground state is about the same for all systems, ~0.5, suggesting a common mechanism for this process. (auth)

6583 ADSORPTIVE CAPACITY OF HIGHER AND LOWER OXIDES OF V, Mn, AND U OBTAINED BY THEIR MUTUAL CONVERSIONS. Mardaleishchvili, R. E.; Daneliya, A. P.; Kon, M. Ya. Vestn. Mosk. Univ., Ser. II. Khim.; 12: No. 4, 387-97 (Jul-Aug 1971). (In Russian).

Experimental confirmation of the existence of two types of adsorptive centers (Me and O centers) on the surface of metal oxides was obtained for V, Mn, and U oxides as examples. The ratio of numbers of these centers on the surface is the same as the ratio of amounts of metal and oxygen in the corresponding oxide. The oxidation or reduction of the given oxide at temperatures that provide the low rate of the process (2 to 5% per hour) results in higher or lower oxides, respectively. These oxides were found to retain the same number of Me centers on the surface as the initial oxide whereas the number of O centers is changed in accordance with the stoichiometric content of oxygen in the oxide. (auth)

6584 CRYSTAL STRUCTURE OF α-Na_2UO_4. Kovba, L. M. Vestn. Mosk. Univ., Ser. II. Khim.; 12: No. 4, 489-91(Jul-Aug 1971). (In Russian).

The structure of sodium monouranate (α-form) consists of $(UO_2)O_2$ chains of UO_6 octahedrons that are linked by edges. (auth)

Radiation and Nuclear Chemistry

Refer also to abstracts 6701 and 8227.

6585 (AECL-3997) CHEMISTRY AND MATERIALS DIVISION PROGRESS REPORT, APRIL 1-JUNE 30, 1971. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 105p. (PR-CMa-17). Dep. NTIS (U. S. Sales Only). AECL $2.00.

ACTIVATION ANALYSIS—research progress on
AMINES—radiolysis of, transient species from
ANALYTICAL CHEMISTRY—research progress on
CALCIUM FLUORIDES—radiation effects on optical properties of
COATINGS—development of high-temperature oxidation resistant
COPPER—radiation effects on defects in
DEUTERIUM—separation from hydrogen, electrolytic
DEUTERONS—effects on stressed Zircaloy-2
ELECTRON MICROSCOPY—research progress on
GASES—radiolysis of, research progress on
HYDROGEN—separation from deuterium, electrolytic
IONS—channeling of, research progress on
KRYPTON IONS—ranges of, implanted at 40 keV
MASS SPECTROMETERS—performance evaluation of spark-source
MERCURY IONS—implantation in silicon at 40 keV, effects from
METALS—radioinduced defects in, research programs on
NEUTRONS, FAST—flux measurements in SLOWPOKE reactor using threshold detectors
NUCLEAR REACTION ANALYSIS—research progress on
RADIATION CHEMISTRY—research progress on
REACTORS, RESEARCH—neutron flux measurements in SLOWPOKE, threshold detectors for fast
SILICON—mercury ion implantation at 40 keV in, effects from
ZIRCALOY-2—radiation effects on stressed, deuteron
ZIRCONIUM ALLOYS—precipitation in
—cracking of, research progress on (M.C.G.)

6586 (ORO-3781-8) INVESTIGATION OF GAMMA-RAY INDUCED POLYMER FORMATION OF THE CARBORANES. Annual Progress Report. Klingen, Theodore J. (Mississippi Univ., University. Dept. of Chemistry). 1 Nov 1971. Contract AT(40-1)-3781. 113p. Dep. NTIS.

Research progress is reported on the γ-ray induced polymer formation in 1,2-dicarba-closo-dodecaborane(12) and its C-alkyl and alkyne derivatives. The carboranes included are 1-ethyl; 1-isopropenyl-, and 1-vinyl-o-carborane. (D.H.M.)

For an abstract of a dissertation included in this report see: 6587.

6587 (ORO-3781-8, Pt.1) RADIATION CHEMISTRY OF ICOSAHEDRAL CARBORANE CONDENSED PHASES: 1-VINYL- AND 1-ISOPROPENYL-o-CARBORANE. Wright, John Ricken (Mississippi Univ., University. Dept. of Chemistry). Aug 1971. 104p.

Thesis.

The radiation chemistry of 1-vinyl-o-carborane and 1-isopropenyl-o-carborane was studied in an effort to locate the functional groups of these molecules, characterize the fundamental events, and elucidate the nature of carborane condensed phases. Some results obtained are that bulk 1-vinyl-o-carborane is now thought to polymerize in a conventional vinyl manner, and hydrogen atoms are the probable chain initiators; the solid state reaction of 1-isopropenyl-o-carborane may be related to so-called topotactic polymerizations where in lattice periodicity determines the stereochemistry of the product; and in characterizing the 1-vinyl-o-carborane's plastic crystalline properties there is an observed lack of a discontinuity at the melting temperature in the Arrhenius plot of G(-m) data. (D.H.M.)

6588 (RRL-2310-358) QUARTERLY REPORT [ON RADIATION RESEARCH], JULY 1, 1971-SEPTEMBER 30, 1971. Fundamental Research No. 6041. (Mellon Inst., Pittsburgh, Pa. Radiation Research Labs.). 11 Oct 1971. Contract AT(30-1)-2310. 24p. Dep. NTIS.

Research progress is reported in the following areas: the radiation chemistry of aqueous solutions of 5-halouracils; ESR study of radicals produced in irradiated aqueous solutions of 5-halouracils; steady state and pulse radiolysis studies of aqueous solutions of 5-bromoorotic acid; steady state and pulse radiolysis studies of $Cl_2^-\cdot$ reactivity in micellar systems; time resolved ESR studies; reactions of O^- with substituted furan rings; reactions of $\dot{S}O_4^-$; radiation chemical studies on aqueous solutions of hydrocarbons; product analysis of radiolysis of aqueous solutions of benzene; electron reactions in the gas phase; ion current decay in pulse irradiated hydrocarbons; analysis of data from competitive electron scavenging experiments; electron scavenging in liquid xenon. (D.H.M.)

6589 (RRL-2310-360) ANNUAL REPORT, JULY 1, 1970-SEPTEMBER 30, 1971. (Mellon Inst. of Science, Pittsburgh, Pa. Radiation Research Labs.). 18 Oct 1971. Contract AT(30-1)-2310. 22p. Dep. NTIS.

6590 SOME APPLICATIONS OF TIME-DEPENDENT RATE CONSTANT THEORY TO RADIATION CHEMISTRY. Schwarz, Harold A. (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys.; 55: No. 8, 3647-50(15 Oct 1971).

Rate constants for diffusion-limited reactions decrease with time after the start of an experiment, an effect due to the time required to establish a diffusion gradient of each reactant around the other. Slow reactions between ions also exhibit a time dependence because a finite time is required to establish the Boltzmann distribution of each type of ion around the other. The latter effect appears as an increase of rate constant with time for reactions between ions of opposite charge and a decrease for ions of similar charge. These time dependent effects are applied to the picosecond pulse radiolysis results of Wolff et al. on electron formation and decay in acetone and acid solutions, and to some competition experiments of Czapski and Peled. Effects attributed by them to reactions of a precursor of the hydrated electron are shown to be similar to expected consequences of time-dependent phenomena of the hydrated electron itself. (auth)

6591 RADIATION CHEMISTRY OF WATER. Draganic, Ivan G.; Draganic, Zorica D. Physical Chemistry. Volume 26. A Series of Monographs. New York; Academic Press Inc. (1971). 254p. $14.00.

The radiation chemistry of water is considered, with a broad survey of those short-lived species that cause the chemical changes in irradiated water and aqueous solutions. Topics covered include: historical survey of the radiation chemistry of water, reactions of radiation with water, primary products of water radiolysis (hydrated electrons, hydrogen atoms and molecules, OH radicals, and H_2O_2), radiation-chemical yields of these products, kinetic-diffusion model, radiation sources and irradiation techniques, and aqueous chemical dosimeters. (M.C.G.)

6592 ROLE OF FREE RADICALS IN THE RADIATION CHEMISTRY OF POLYMERS. Turner, D. T. (Drexel Inst. of Tech., Philadelphia). J. Polym. Sci., Part D; 5: 229-383 (1971).

Experimental data that seem pertinent to an understanding of the role of free radicals in the radiation chemistry of polymers are displayed. Attention is concentrated mainly on studies that permit estimates of crosslinking and fracture of the polymer molecules. Topics covered include: formation and distribution of intermediates, detection and estimation of intermediates, yields of products, scavenging of intermediates, and chemistry of intermediates. (368 references) (M.C.G.)

Radiation Effects

Refer also to abstract 7727.

6593 (COO-1728-3) CHEMICAL CONSEQUENCES OF THE AUGER EFFECT IN THYROXINE AND ITS ANALOGUES. Final Technical Report. [Toledo Univ., Ohio]. [1971]. Contract AT(11-1)-1728. 10p. Dep. NTIS.

Research progress is reported on x-radiation effects on iodothyronines, iodotyrosines, and iodobenzene. (D.H.M.)

6594 TRAPPED ELECTRON IN THE IRRADIATED SINGLE CRYSTAL OF ICE DOPED WITH SOME IMPURITIES: ITS FORMATION AND PHOTOBLEACHING AT 77°K. Kawabata, Keisuke (Radiation Center of Osaka Prefecture). J. Chem. Phys.; 55: No. 8, 3672-81(15 Oct 1971).

It is found that single crystals of ice doped with $10^{-4}-10^{-2}$M ammonium fluoride and alkali fluoride color considerably by gamma irradiation at 77°K. Their spectra all are the same as the one in the pure crystal (the peak is at 6400 Å), and the largest optical density is about 6 times as high as that in the pure crystal. These enhanced absorptions represent an increase of the concentration of the trapped electrons in the doped samples. D_2O crystals doped with NH_4F show a similar increase, having the same spectrum as that in pure D_2O crystal (the maximum yield is about 10 times of that in the pure H_2O crystal). The increased electrons are not due to those produced in the locally amorphous parts. Other samples doped with such impurities as NH_4Cl, NH_4OH, KCl, NaOH, etc., do not show such coloring. Trapping sites for these electrons are considered. Photobleaching of the pure and the doped crystal shows simple and uniform decays and the original spectrum is almost unchanged by the stimulation at any wavelength. The spectrum represents only one species trapped in one definite form of potential. The trapped electron in the pure and the doped crystal show a low bleaching efficiency for the wavelength corresponding to the peak of the spectrum. Wavelength dependence of the bleaching quantum efficiency shows a steep rise from roughly 5000 Å to the higher energy side. The peak of the optical absorption spectrum is a transition to the bound state. The asymmetrical tail in the high energy side of the spectrum corresponds to the transition to the higher excited levels, bound or in the continuum. (auth)

6595 RADIOTHERMOLUMINESCENCE OF CRYSTALLINE AND GLASSY METHANOL. II. RADIOTHERMOLUMINESCENCE OF THE METHANOL-WATER SYSTEM. Roszak, W.; Kroh, J. (Technical Univ., Lodz, Poland). Radiochem. Radioanal. Lett.; 7: No. 4, 253-8(15 Aug 1971).

The radiothermoluminescence (RTL) spectrum is strongly dependent on the structure of the matrix. It seems, therefore, that RTL provides a very useful tool for structural examination of various solids and frozen solutions. The present work was undertaken in order to establish a correlation between the relative intensities of RTL peaks at T_1, T_2, T_3, and the water content of the methanol matrix. (auth)

6596 CHEMICAL EFFECTS IN γ IRRADIATED ^{131}I DOPED NaCl CRYSTALS. Dema, I. (Inst. of Atomic Physics, Bucharest). Radiochem. Radioanal. Lett.; 7: No. 4, 245-51(15 Aug 1971).

The γ-induced changes in the chemical state of $^{131}I^-$ ions, incorporated in NaCl crystals were studied. On irradiation at room temperature a substantial amount of $^{131}I^-$ is converted into iodine which, on dissolution in water, gives oxidized forms of iodine. On heating the irradiated doped crystals, oxidation of ^{131}I ions occurs. The experimental results are explained by interaction of $^{131}I^-$ ions with holes and electrons created by irradiation. (auth)

6597 AQUOLUMINESCENCE FROM γ-IRRADIATED ALKALI HALIDES. II. SPECTRAL ANALYSIS AND EFFECT OF pH OF THE MEDIUM. Arnikar, H. J.; Damle, P. S.; Chaure, B. D. (Univ. of Poona). J. Chem. Phys.; 55: No. 8, 3668-71(15 Oct 1971).

The emission of a bluish-green glow during the dissolution of γ-irradiated alkali halides was recently reported under the name of aquoluminescence. Details for its production, observation, and for the measurement of its intensity are presented. Typical oscillograms of the glow and its spectral analysis are also given. A probable mechanism for the origin of aquoluminescence is suggested consistent with the effects observed thereon due to pH of the medium and the addition of electron acceptors and donors prior to dissolution of the irradiated salt. (auth)

6598 EPR STUDY OF FREE RADICALS IN AN ADAMANTANE MATRIX. Lloyd, Roger Vaughan. Pittsburgh; Carnegie-Mellon Univ. (1971). 88p. University Microfilms Order No. 71-20,638. Thesis.

The use of adamantane as a matrix for the preparation and study of free radicals has been developed. It has been found that x-irradiation of impurities selectively introduced into adamantane produces specific free radicals which can be conveniently studied by EPR. Three classes of compounds have been irradiated; aliphatic amines, aliphatic isocyanates and isothiocyanates, and aromatic analogs of toluene (aniline and the picolines). From the first class were obtained the aminoalkyl radicals RR′Ċ-NR″R‴. EPR spectral parameters were obtained for twenty-four of these radicals and these data, combined with theoretical calculations, have shown that the radicals have a non-planar anti configuration about the radical site. From the second, nine isocyanatoalkyl and isothiocyanatoalkyl radicals RR′Ċ-NCO(s) were obtained and analyzed by EPR. In contrast to the aminoalkyl radicals, these were shown to be planar. Theoretical calculations suggest that they are also non-linear. Finally, the benzyl and azabenzyl (i.e., nitrogen-substituted benzyl) radicals were studied. The effects of the nitrogen substitution on the electronic structure of benzyl radical are discussed. (Diss. Abstr. Int., B)

6599 ZERO-FIELD PARAMETERS OF FREE CH_2: SPIN-ORBIT CONTRIBUTIONS IN XENON. Wasserman, E.; Hutton, R. S.; Kuck, V. J.; Yager, W. A. (Bell Telephone Labs., Inc., Murray Hill, N. J. Rutgers-The State Univ., New Brunswick, N. J.). J. Chem. Phys.; 55: No. 5, 2593-4(1 Sep 1971).

The EPR spectra of CH_2 and CD_2 were each obtained in octafluorocyclobutane (OFCB) and SF_6 after irradiations of solid solutions of the corresponding diazirine at 4°K. The zero-field parameters, D and E, were extracted to yield, in OFCB: D_{CH_2} = 0.6430 cm^{-1}, E_{CH_2} = 0.01370 cm^{-1} and D_{CD_2} = 0.6814 cm^{-1}, E_{CD_2} = 0.0170 cm^{-1}; in SF_6: D_{CH_2} = 0.6122 cm^{-1}, E_{CH_2} = 0.0206 cm^{-1} and D_{CD_2} = 0.6505 cm^{-1}, E_{CD_2} = 0.0237 cm^{-1}. In SF_6 two distinct methylene spectra were observed; annealing the samples at 77°K reduced one system to leave the more prominent spectrum with D and E given above. The observed differences in D between the isotopes in a given matrix are due to differences in the zeropoint motion. D is reduced by motional averaging, an effect which is less in the heavier, deuterated molecule. (D.H.M.)

6600 CHANGE IN THE CRYSTALLINITY OF POLYETHYLENE DURING γ-IRRADIATION. Korodenko, G. D.; Narzullaev, B. N.; Karimov, S. N. (Tadzhik State Univ., Stalinbad, USSR). Dokl. Akad. Nauk Tadzh. SSR; 14: No. 1, 17-20(1971). (In Russian).

Polyethylene belongs to a class of polymers that are largely cross-linked by irradiation in a vacuum. Samples of high-pressure polyethylene 70-μ thick were maintained at 108°C for 2 hr in a vacuum in order to achieve a uniform crystalline structure. The samples were then subjected to ^{60}Co gamma radiation at 30°C for doses as high as 10^8 R. Subsequent x-ray analysis and infrared spectroscopy provided evidence of the degree of crystallinity remaining. With increased radiation dose the degree of crystallinity fell from 55 to 33% (2×10^5 R), and then proceeded to rise, reaching 50% at 10^8 R. (K.S.W.)

6601 POLYPHENYLENES. Noren, G. K.; Stille, J. K. (Univ. of Iowa, Iowa City). J. Polym. Sci., Part D; 5: 385-430 (1971).

The existing literature, covering methods of synthesis, physical properties, and uses of high-molecular-weight polyphenylenes, is reviewed. Topics covered include: synthesis, miscellaneous reactions and uses, and properties of polyphenylene, including radiation stability. (129 references) (M.C.G.)

6602 COMPETITION IN CHARGE CAPTURE BY ADDITIVES IN γ-IRRADIATED POLY(VINYL CHLORIDE). Kotov, B. V.; Pravednikov, A. N. (Physical-Chemical Inst., Moscow). Dokl. Akad. Nauk SSSR; 198: No. 1, 134-7(1 May 1971). (In Russian).

A study was made of the competition between electron donors and acceptors in various combinations in poly(vinyl chloride) that had been irradiated at 77°K. A number of quinone derivatives (chloranil, bromanil, duroquinone) were used as acceptors; N,N,N-tritolylamine, aromatic hydrocarbons such as anthracene, and N,N,N′,N′,-tetramethyldiaminodiphenylmethane were used as donors. The study was organized into donor—donor systems, acceptor—acceptor systems, and donor—acceptor systems. Optical absorption spectra of the irradiated poly(vinyl chloride) were examined for the presence or absence of ion-radicals of the additives. The results are discussed and mechanisms for explaining the phenomena observed are proposed. (K.S.W.)

6603 THERMAL DEGRADATION OF IRRADIATED POLYETHYLENE. Pavlova, Zh. D.; Leshchenko, S. S.; Karpov, V. L. (Scientific-Research Physical-Chemical Inst., Moscow). Vysokomol. Soedin., Ser. B; 13: No. 6, 451-3(Jun 1971). (In Russian).

Radiation is known to improve the desirable properties of polyethylene through induction of certain changes in the polymer network. The effect of these changes on the thermostability of this polymer in the absence of air was investigated by observing changes in weight of polymer samples while these samples were maintained at a given temperature. The irradiation of polyethylene was conducted at room temperature in a He atmosphere, employing a dose range of 1 to 300 MR from a ^{60}Co source yielding 300 R/sec. Degradation rates were plotted as a function of the extent of degradation. The energies of activation of gas evolution from low-density polyethylene irradiated at various dosages were calculated. With increased radiation dose the energy of activation rose. (K.S.W.)

6604 RADIATION CHEMISTRY OF POLY(PROPYLENE OXIDE). Roberts, G. P. (Northwestern Univ., Evanston, Ill.); Budzol, M.; Dole, Malcolm. J. Polym. Sci., Part A-2; 9: No. 10, 1729-45(Oct 1971).

Atactic, isotactic, and optically active poly(propylene oxides), PPOx, were irradiated with both γ rays and electron beams. Up to a dose of 37 Mrad no change could be detected in the optical activity. G values for hydrogen evolution decreased as compared to polypropylene in about the same ratio as $G(H_2)$ of polyoxymethylene decreased as compared to polyethylene. G values for crosslinking and scission, estimated by means of gelation theories of Saito and Inokuti, were found to be greater for isotactic than for atactic PPOx. The behavior of transient infrared and ultraviolet absorption bands is discussed. Intrinsic viscosity data indicate a rapid initial chain degradation whereas CO gas and OH group production is linear with dose. Evidence for the conversion of one type of free radical to another on heating an irradiated sample from 77°K to room temperature is based on the behavior of transient infrared and ultraviolet absorption bands. (auth)

6605 FORMATION AND REACTIONS OF RADIATION-INDUCED FREE RADICALS IN CHEMICALLY MODIFIED COTTON CELLULOSES. Chidambareswaran, P. K. (Cotton Technological Research Lab., Bombay); Sundaram, V.; Prakash, Jai; Verma, N. C.; Singh, B. B. J. Polym. Sci., Part A-1, 9: No. 9, 2651-8(Sep 1971).

With a view to assessing the role of chemical substitutions in the modification of radiation effects on cotton fibers, the induction and post-irradiation behavior of free radicals in γ-irradiated pure, mercerized, benzoylated, and allylated cottons were investigated by ESR spectroscopy. While mercerization and allylation were found to influence both the nature and yield of radicals, benzoylation reduced only the yield. These substitutions, which have been found to protect cotton fibers against radiation damage, therefore act differently at the molecular level. (auth)

6606 USE OF METASTABLE COLOUR-CENTRES IN ALKALI-METAL HALIDE CRYSTALS AND IN SILICA GEL TO CATALYSE EXCHANGE BETWEEN TRITIUM GAS AND HYDROCARBONS. Cowell, B. J.; Matthews, K. M.; Odell, A. L. (Univ. of Auckland, New Zealand). J. Chem. Soc., D; No. 20, 1264 (20 Oct 1971).

Color-centers of low stability induced by γ-radiation in sodium chloride, potassium chloride, and silica gel act as effective catalysts for the exchange reaction between tritium gas and hydrocarbons although the exchange is accompanied by extensive fragmentation and polymerisation. (auth)

6607 PHOTOINDUCED HOLE-ELECTRON RECOMBINATION IN A γ-IRRADIATED SINGLE CRYSTAL OF L-CYSTINE DIHYDROCHLORIDE. Akasaka, Kazuyuki; Kominami, Shiro; Hatano, Hiroyuki (Kyoto Univ.). J. Phys. Chem.; 75: No. 24, 3746-50 (25 Nov 1971).

Photoinduced recombination of electrons and holes produced by γ irradiation and subsequently trapped as disulfide ions at 77°K in a single crystal of L-cystine dihydrochloride was studied by ESR and optical absorption spectroscopy. Whereas the disulfide anion gives an absorption around 400 nm, the corresponding cation gives a broad absorption peaking at 500 nm. The wavelength dependence of the photoinduced decay of ESR signals in the irradiated crystal has given evidence that the recombination is initiated by the photoexcitation of the cationic species. The first-order nature of the decay indicates that the recombination takes place between the ion pair separated by at least a few molecules as estimated from the line width of the ESR signal. An electron tunneling is suggested for the mechanism. (auth)

Radiation Processes

6608 INDUCTION OF THE THALLIUM(I)–THALLIUM(III) EXCHANGE BY IRON(II). Warnqvist, Bjoern; Dodson, R. W. (Brookhaven National Lab., Upton, N. Y.). Inorg. Chem.; 10: No. 11, 2624-6(Nov 1971).

The thallium(I)–thallium(III) electron exchange was found to be accelerated by iron(II). Effects of x-rays emitted from the decay of the ^{204}Tl tracer were not found to influence the results materially. (J.G.B.)

6609 RADIATION-INDUCED OXIDATION OF LIQUID SULFUR DIOXIDE CONTAINING OXYGEN AND WATER. Schoenherr, Siegfried (Arbeitsgruppe Reaktionsverhalten und Syntheseprinzipien, Freiberg, Ger.); Seidel, Helmut; Rothschild, Walter G. J. Phys. Chem.; 75: No. 23, 3631-3(11 Nov 1971).

A study was made, based on the equation $SO_2 \xrightarrow{h\nu} SO + O$, of the effect of precisely controlled oxygen atmosphere and of exactly known amounts of water on the ^{60}Co γ-ray-induced product formation in the respective liquid sulfur dioxide systems. It was concluded that the radiation-induced products in anhydrous liquid sulfur dioxide systems can be explained satisfactorily on the basis of a few radical steps involving O and SO, the "primary" decomposition products; however, in the presence of water the mechanism no longer accounts quantitatively for the reaction products nor (even qualitatively) predicts the observed temperature dependence. (D.H.M.)

6610 RADIOCHEMICAL COPOLYMERIZATION OF METHYL ACRYLATE AND ACRYLONITRILE. Chapiro, A.; Saygili, N. (Centre National de la Recherche Scientifique, Meudon, France). J. Chim. Phys.; 68: No. 7, 1073-7(Jul 1971). (In French).

The kinetics of the γ-initiated bulk copolymerization of methyl acrylate (MA) and acrylonitrile (AN) were investigated. Depending on the composition of the monomer mixture, the reaction occurs either in homogeneous or precipitating media. In mixtures containing 0 to 20% AN, the copolymerization is strongly affected by the gel effect. From 50 to 70% AN the copolymer precipitates in the form of swollen particles. The corresponding conversion curves exhibit a strongly auto-accelerated character, because chain propagation is hindered while propagation occurs readily in the swollen polymer particles. For AN concentrations in excess of 80% the powder particles are no longer swollen and termination occurs by the burying of growing chains. The glass transition temperatures (Tg) of the copolymers were measured and a linear relation was found between Tg and the composition. (France)

6611 WOOD–PLASTIC COMBINATION PRODUCED BY γ-IRRADIATION. III. Fukumoto, Tsugio; Takauchi, Masayuki; Hatanaka, Kazuo; Akagi, Ryuichi; Tsurugi, Jitsuo. Annu. Rep. Radiat. Center Osaka Prefect.; 11: 134-8(1970).

Data are given on the irradiation for the production of wood–plastic combination (WPC) in the new irradiation pool facility (100-kCi ^{60}Co source) of the Institute. Problems to be solved for the practical production of WPC are also discussed. Samples of persimmon, hornbeam, maple, and pasania were impregnated with an excess vinyl acetate under vacuum. The impregnated samples were then irradiated with the ^{60}Co radiation source. The dose rates used were 2.8 Mrad/hr (for experiments termed the perpendicular method) and 1.98 Mrad/hr (for experiments termed the horizontal method). The latter was found to give higher values of conversion and polymer loading with a total dose of 2 to 3 Mrad at both dose rates. From the results of these experiments and of the trials producing shuttle from the irradiated samples, hornbeam was found to be available for producing shuttle as well as persimmon. (auth)

6612 RADIATION-CHEMICAL POLYMERIZATION OF VINYL CHLORIDE IN THE GAS PHASE. Tikhomirov, V. S.; Serenkov, V. I. Plast. Massy; No. 6, 6-9(Jun 1971). (In Russian).

The general reaction rate equation was studied for polymerization in which the steps of initiation and breakage were random order reactions with respect to their dependence on γ radiation dose and concentration of the polymerizing molecule. An equation that permits the determination of the order of the initiation reaction and of the destruction of the chain is introduced. The effects of basic parameters (initial monomer pressure, temperature, magnitude of the radiation dose) on the radiochemical polymerization rate were found for vinyl chloride in the gaseous phase. The vinyl chloride polymerization was apparently effected through an ionic mechanism. (tr-auth)

6613 RADIOTHERMOLUMINESCENT INVESTIGATION OF ORIENTED POLYMERS. Shulyak, A. D.; Erofeev, V. S.; Patrikeev, G. A.; (and others). Vysokomol. Soedin., Ser. A; 13: No. 5, 1097-1102(May 1971). (In Russian).

The process of oriented stretching of carbon chain polymers at 20°C was analyzed by studying stretch diagrams and radiothermoluminescent curves of samples with different degrees of orientation. (auth)

6614 ^{60}Co-INITIATED POLYMERIZATION OF STYRENE, VINYL ACETATE, AND THEIR MIXTURES IN THE PRESENCE

OF A RADICAL INITIATOR. Niezette, Joseph; Desreux, Victor (Univ., Liege). J. Polym. Sci., Part A-1; 9: No. 9, 2469-79 (Sep 1971).

Styrene and vinyl acetate were polymerized by γ-radiation in the presence of α,α'-azobisisobutyronitrile or benzoyl peroxide. Benzoyl peroxide does not affect the vinyl acetate polymerization, but the rate of polymerization is greatly increased by the action of the initiator in the case of the following systems: styrene–α,α'-azobisisobutyromtrile, styrene–benzoyl peroxide, and vinyl acetate–α,α'-azobisisobutyronitrile. For these three systems, the experimental results are in good agreement with a kinetic scheme obtained by assuming an energy transfer process from monomer-excited molecules to the initiator; this process does not occur in the first system, and the initiation rate is determined only by the vinyl acetate concentration. In the case of the polymerization of mixtures of the two monomers, the action of α,α'-azobisisobutyronitrile and that of benzoyl peroxide are practically the same; that is, the shape of the polymerization curve may be understood on the basis of an energy transfer from styrene excited molecules to the initiator. (auth)

6615 RADIATION-INDUCED POSTPOLYMERIZATION OF TRIOXANE IN THE SOLID STATE. III. EFFECT OF OXYGEN ON THE POSTPOLYMERIZATION OF TRIOXANE. Ishigaki, Isao; Ito, Akihiko; Iwai, Tadashi; Hayashi, Koichiro (Japan Atomic Energy Research Inst., Takasaki). J. Polym. Sci., Part A-1; 2511-21(Sep 1971).

In order to investigate the effects of oxygen on the radiation-induced postpolymerization of trioxane in the solid state, a kinetic study was made. Trioxane was purified by sublimation through Ag_2O and Na–K alloy in vacuo and was irradiated and polymerized in the presence of rigorously dry oxygen. It was found that the initial rate of polymerization and the polymer yields are larger than those obtained in vacuo. By using the kinetic scheme proposed previously the results were analyzed kinetically. It was found that the influence of oxygen on the postpolymerization of trioxane is mainly attributable to the increase in the concentration of active species. The results obtained in dry air were discussed in comparison with those in vacuo reported previously. (auth)

6616 EFFECT OF DOSE RATE ON THE RADIATION-INDUCED POLYMERIZATION OF ETHYLENE IN TERT-BUTYL ALCOHOL. Wada, Takeshi; Watanabe, Terutaka; Takehisa, Masaaki (Japan Atomic Energy Research Inst., Takasaki. Radiation Chemistry Research Establishment, Takasaki, Japan). J. Polym. Sci., Part A-1; 9: No. 9, 2659-72(Sep 1971).

The dependence of the dose rate on the rate of radiation-induced polymerization of ethylene in tert-butyl alcohol containing 5 vol-% water was studied. The reaction was carried out by use of a reactor with a capacity of 100 ml under the following conditions: pressure, 200 kg/cm^2; temperature, 24 ± 3°C; dose rate, $3.7 \times 10^4 - 1.6 \times 10^5$ rad/hr; amount of medium, 70 ml. The dose rate exponents for rate of the polymerization, the molecular weight, and the number of polymer chain were found to be about 0.8, −0.1, and 0.9, respectively. These results were well explained with kinetic results (obtained by a novel analytical method) for the polymerization which contains both first-order and second-order terminations for the concentrations of propagating radical. The individual values of the rate constants in each elementary reaction were also obtained. (auth)

6617 ANNEALING AND MELTING OF POLYOXYMETHYLENE CRYSTALS POLYMERIZED WITHIN IRRADIATED TRIOXANE CRYSTALS. Reneker, Darrell H.; Colson, James P. (National Bureau of Standards, Washington, D. C.). J. Appl. Phys.; 42: No. 12, 4606-14(Nov 1971).

From Meeting of the American Physical Society; Cleveland, Ohio (29 Mar 1971).

Morphological changes produced by the annealing and melting of the polyoxymethylene crystals that polymerize inside irradiated trioxane crystals were observed. The crystals in which the polyoxymethylene chains were oriented parallel to the threefold axis of the trioxane underwent major reorganization when held at 184°C for 30 sec. The polyoxymethylene crystals in which the chain axis was inclined at a large angle with respect to the threefold axis of the trioxane transformed and melted at temperatures approximately 5°C lower. (auth)

6618 PREPARATION OF BLOCK COPOLYMERS BY RADICAL COPOLYMERIZATION. Polowinski, S. (Politechnika, Lodz, Poland). pp 171-4 of Kinetics and Mechanism of Polyreactions. Vol. III. Budapest; Akademiai Kiado (1969).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.3).

The copolymerization of the oligomers of polyacrylic and polymethacrylic acids with styrene was studied. The product of polycondensation of p-cresol with formaldehyde was fractionated into a trimer and an octomer, and each fraction was treated with acrylyl chloride or methacrylyl chloride to produce the matrix for the polymerization. p-Crasyl methacrylate was also prepared and used. Copolymerization was carried out in benzene solution, using either azobisisobutyronitrile or gamma irradiation to initiate the reaction. The composition of the monomer mixtures and the resulting semiladder copolymers was determined, and the polymer molecular weights after hydrolysis and esterification were used to determine the reactivity ratios of the monomers. The copolymers are probably linear, from the absence of the 7.18-mμ vinyl peak. (D.L.C.)

6619 PHYSICO-CHEMICAL PROPERTIES OF POLYVINYL FLUORIDE OBTAINED BY THE ACTION OF GAMMA RADIATION. Yul'chibaev, A. A.; Sirlibaev, T. (Research Inst. for the Chemistry and Tech. of Cotton Cellulose, Tashkent). pp 315-19 of Kinetics and Mechanism of Polyreactions. Vol. III. Budapest; Akademiai Kiado (1969). (In Russian).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.3).

Infrared spectra, solubility, thermostability, and thermomechanical properties of poly(vinyl fluoride) were investigated in polymers which had been obtained by radiation-induced polymerization and by purely chemical methods. Polymerization of the monomer was conducted under the influence of ^{60}Co gamma radiation alone and in the presence of certain additives: acetylene, difluoroethane, benzene, CCl_4, O_2, air, and N_2. The kinetics of polymerization in the absence of additives were studied at the following dose rates: 10, 20, 70, and 100 R sec. A free-radical mechanism was established. The fusion temperature of the polymer lay between 200 to 220°C, depending on the conditions of synthesis. The differences in solubility, thermomechanical properties, and thermostability were attributed to the degree of branching of the macromolecule of poly(vinyl fluoride) obtained by the radiation method. (K.S.W.)

6620 RADIATION-INDUCED COPOLYMERIZATION OF FLUORINE CONTAINING MONOMERS. Tabata, Yoneho; Ishigure, Kenkichi; Higaki, Hiromichi; Oshima, Keichi (Tokyo Univ.). pp 321-8 of Kinetics and Mechanism of Polyreactions. Vol. III. Budapest; Akademiai Kiado (1969).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.3).

The radioinduced copolymerizations of olefins with perfluoroformaldehyde (CF_2O) (carbonyl fluoride) and chlorotrifluoroethylene (CTFE) were studied. Infrared spectra of the copolymers were measured. The olefins polymerized with CF_2O included fluorine-containing olefins; the polymerization using C_2H_4 was studied in more detail. CFTE was polymerized with ethylene, propylene, and isobutylene, and the structure of the CFTE–isobutylene copolymers was studied using x-ray diffraction and NMR. (D.L.C.)

6621 MOLECULAR WEIGHT DISTRIBUTIONS IN RADIATION-INDUCED POLYMERIZATION. II. GAMMA-RAY INDUCED POLYMERIZATION OF METHYL METHACRYLATE. Huang, Robert Y. M.; Mayer, Gunter (Univ. of Waterloo, Ont.). pp 329-33 of Kinetics and Mechanism of Polyreactions. Vol. III. Budapest; Akademiai Kiado (1969).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.3).

A study was made of the polymerization behavior and kinetics of liquid and solid methyl methacrylate at 45°C to −65°C. The molecular weight distributions of the polymers were determined using gel permeation chromatography and related to the polymerization conditions. The results indicate that chain termination occurs by combination at low temperatures below 0°C. (D.L.C.)

6622 RADIATION-INDUCED POLYMERIZATION OF METHACRYLOYL DERIVATIVES OF ANABASINE AND PIPERIDINE. Musaev, U. N.; Babaev, T. M.; Tillaev, R. S. (Research Inst. of Chemistry and Tech. of Cotton Cellulose, Tashkent). pp 335-40 of Kinetics and Mechanism of Polyreactions. Vol. III. Budapest; Akademiai Kiado (1969). (In Russian).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.3).

N-methacryloylpiperidine (MP) and N-methacryloylanabasine (MA) were distilled under reduced pressure and sealed in previously evacuated glass ampules. Gamma-irradiation of tha ampules was conducted at dose rates of 16 to 305 R/sec. The yield of the product polymers was determined as a function of total radiation dose after extraction of unreacted monomer and drying in a vacuum. The effects of temperature and dose rate on polymerization rate were studied. The physicochemical properties of MP and MA polymers investigated included density, solubility, viscosity of solutions, and infrared spectra. (K.S.W.)

6623 RADIOCHEMICAL POLYMERIZATION OF ACRYLIC ACID IN METHANOL SOLUTION. Chapiro, Adolphe; Laborie, Francoise (CNRS, Bellevue, France). pp 387-90 of Kinetics and Mechanism of Polyreactions. Vol. III. Budapest; Akademiai Kiado (1969). (In French).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.3).

Acrylic acid was purified by double distillation in the presence of copper. The acrylic acid–methanol solution was then irradiated with ^{60}Co γ rays at 15 rad/min at 20°C. Polymerization was followed every 2 min by dilatometry. Final conversion was determined by weighing the polymers following acetone precipitation. At monomer contents below 66%, the mixture remained homogeneous and transparent throughout irradiation. Between 66 and 76%, an opalescent gel was obtained. Above 76%, the polymer precipitated as a white powder. The polymer mixture was fractionated through selective solubility. (H.B.G.)

6624 POSITRON ANNIHILATION IN IRRADIATED ORGANIC CRYSTALS. Tabata, Yoneho; Ito, Yasuo; Yamashita, Hiroshi; Oshima, Keichi (Tokyo Univ.). pp 15-21 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiado (1969).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

Positron annihilation was used to study the structure and trapped species in the solid-state polymerization of N-vinylcarbazole and dimethyl itaconate. Gamma irradiation by ^{60}Co and ^{22}Na was used, and both the in-source and post-polymerizations of N-vinylcarbazole were studied. The results are interpreted in terms of positronium formation and positron solvation. (D.L.C.)

6625 INVESTIGATION OF THE MECHANISMS OF ^{60}Co γ-INDUCED POLYMERIZATION OF CRYSTALLINE TRIOXANE. Boehlke, K.; Jaacks, V.; Mathes, N. (Univ., Mainz). pp 29-32 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiado (1969). (In German).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

Ultrapure crystalline trioxane formed a thin surface layer in a 50-ml round flask. The process carried out was either in-source radiation-induced polymerization at 53.5°C or post-polymerization in which the samples were irradiated at −75°C and were polymerized at 55°C. It was assumed that radiation-induced polymerization proceeded through polyoxymethylene cations. Through addition of sodium ethylate, the cations could be transformed into ethoxyl groups. Following isolation, purification, and acid hydrolysis, the groups were detected in trace amounts by gas chromatography. Findings and possible interpretations of underlying mechanisms were discussed. (H.B.G.)

6626 RADIOCHEMICAL COPOLYMERIZATION IN MIXTURES OF CRYSTALLIZED MONOMERS. Chapiro, Adolphe; Lesaulnier, Pierre (CNRS, Bellevue, France). pp 33-5 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiado (1969). (In French).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

Copolymerization, induced by γ irradiation, in binary systems comprising two crystallized monomers, was aborted for two purposes. First, to determine the relationship existing between physical structure of the polymerizing milieu and the kinetics of polymerization. Second, to study both composition and structure of the obtained polymers or copolymers especially with respect to eutectic mixtures. Two pairs were studied: lauryl methacrylate (MAL)–styrene (St), and acenaphtylene (ACN)–N-vinylcarbazole (NVC). The pairs formed eutectic mixtures of the following composition: 28% MAL, 72% St; and 68% NVC, 32% ACN. The monomer mixtures were purified, degassed under vacuum, crystallized at 0°C, and irradiated at 1900 and 1000 rad/min of ^{60}Co γ rays. Copolymer composition was determined by infrared analysis. (H.B.G.)

6627 RADIOCHEMICAL POLYMERIZATION OF ACRYLONITRILE IN CRYSTALLIZED MIXTURES WITH DIFFERENT ADDITIVES. Chapiro, Adolphe; Mankowski, Zbigniew (CNRS, Bellevue, France). pp 37-40 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiado (1969). (In French).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

Acrylonitrile and its additives were purified by distillation. Five cc of the mixture were degassed in an ampule which was then closed under vacuum. The mixture was then melted, homogenized, and dropped into liquid nitrogen. Irradiation was performed with ^{60}Co γ rays at 1380 and 780 rad/min. After irradiation, the ampule content was put into acetone of 25°C to reduce post-polymerization. The polymer was then filtered, washed, dried, and weighed. The mean molecular mass of the polyacrylonitrile was then determined by viscometry in dimethylformamide at 25°C. Seven different additives were used. The polymerization rate was studied as a function of additive concentration. It was concluded that the additives, by modifying the crystalline structure of the monomer, simultaneously caused inhibition of priming and propagation of chains. In the low-temperature phase, the additives inhibited propagation. (H.B.G.)

6628 INVESTIGATION OF MOLECULAR MOBILITY IN SOLID, IRRADIATED ACRYLONITRILE. Mikhailov, A. I.; Bol'shakov, A. I.; Mel'nikov, V. P.; Barkalov, I. M.; Gol'danskii, V. I. (Inst. of Chemical Physics, Moscow). pp 41-4 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiado (1969). (In Russian).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

A low-temperature phase of acrylonitrile was chosen for this investigation of reaction mechanism in solid-phase polymerization. The acrylonitrile was freed from the metastable state and irradiated with ^{60}Co gamma radiation at doses of from 1 to 20 MR. Samples were thermostated at 156°K for various lengths of time in order to determine the effect of time on polymer yield. Some samples were preliminarily bleached at 77°C with a special lamp before polymerization, but the yield in this case was smaller. On the basis of the reaction data, mechanisms and molecular mobility in the solid state are discussed as relating to proton resonance and radical destruction. (K.S.W.)

6629 RADIATION-POLYMERIZATION OF ACRYLONITRILE IN A UREA COMPLEX AT 77°K. Kiss, L.; Polgar, C. (Research Inst. of the Plastics Industry, Budapest). pp 45-8 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiado (1969). (In Russian).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

The polymerization of acrylonitrile at low temperatures was studied, using the channel complex acrylonitrile–urea which can promote polymerization. Irradiation of the complex with ^{60}Co radiation at 100 R/sec was usually conducted at 77°K; stepwise warming of the sample from −110 to −36°C produced stepwise progress in polymerization. Light from an incandescent lamp favored the reaction, whereas darkness inhibited the polymerization process. A significant amount of post-irradiation polymerization invariably occurred. Samples of the acrylonitrile–urea complex failed to polymerize in the absence of γ-radiation, even after many hours of exposure to visible light at 77°K. (K.S.W.)

6630 FACTORS AFFECTING THE RADIATION POLYMERIZATION OF MALEMIDES. Ivanov, V. S.; Petrukhno, L. A.; Musienko, L. F. (Leningrad State Univ.). pp 53-6 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiado (1969). (In Russian).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

The radiation-induced polymerization of N-phenylmaleimide (PMI) was studied as a function of the purity of the monomer, employing ^{60}Co gamma radiation at a rate of 0.73 mR/hr. The polymerization rate was higher in the solid phase and melt than the rate exclusively in the liquid state. The role of crystal dimensions and structural defects was also investigated by observing the radiation polymerization of the binary systems: PMI–fluorene and PMI–biphenyl. (K.S.W.)

6631 SENSITIZATION OF RADIATION POLYMERIZATION IN THE SOLID PHASE. Ivanov, V. S.; Migunova, I. I. (Leningrad State Univ.). pp 57-60 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiado (1969). (In Russian).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

The solid-phase radiation polymerization of N-p-tolylmaleimide at 120°C was investigated in the presence of ^{60}Co γ-radiation at a rate of 0.58 MR/hr for 3 hr. The sensitization of this reaction by CO_2, Ar, and N_2 was explored by determining the polymerization rate in the presence of each gas as a function of its concentration. The most efficient sensitizer of the three gases was CO_2. In another series of experiments, the sensitization of the polymerization reaction by X_3CCOOH was similarly measured, where X was F, Cl, Br, or I. Of the four haloacetic acids studied, CBr_3COOH was the most efficient sensitizer. (K.S.W.)

6632 SOLID-STATE POLYMERIZATION OF N-SUBSTITUTED ACRYLAMIDES AND METHACRYLAMIDES. Zurakowska-Orszagh, J. (Univ. of Warsaw). pp 61-8 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiado (1969).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

Acrylamides and methacrylamides with tert-alkyl, sec-alkyl, and aryl substituents on the N atoms were prepared for the study of the effects of small changes in the structure on the reactivity, polymerization rate, and polymer properties. Gamma irradiation at 28°C and 13 to 40 r/sec dose rates was used to induce polymerization. (D.L.C.)

6633 RADIOCHEMICAL POLYMERIZATION OF SOME VINYL MONOMERS IN GLASSY MIXTURES WITH ANILINE. Azikonda, Lioubov; Perec-Jaulin, Liliana (CNRS, Bellevue, France). pp 86-9 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiado (1969). (In French).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

Aniline, which forms glasses with numerous monomers, was used as solvent. The following monomers were studied: methyl methacrylate (MAM), styrene (St), and acrylonitrile (AN) as well as mixtures between MAM and St. Polymerization proceeded by way of radicals. Phase diagrams of the different systems were determined with a differential thermal analyzer. Samples were degassed, sealed under vacuum, melted, homogenized, and frozen in liquid nitrogen through which transparent glasses were obtained. Irradiation was performed with a 1000-Ci ^{60}Co source with a dose rate of 1740 rad/min. Irradiation occurred at temperatures between −90 to −196°C. The quantity of polymer formation was followed by gravimetry. Mean molecular mass was determined by viscosimetry. It was concluded that polymerization occurred in a narrow temperature range. Mixtures irradiated at −196°C showed a green color. (H.B.G.)

6634 INVESTIGATION OF THE POST-POLYMERIZATION OF N-VINYL CARBAZOLE. Azori, M.; Tuedoes, F. (Central Research Inst. for Chemistry, Budapest). pp 97-101 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiado (1969).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

A kinetic study was made of the post-polymerization of x-irradiated crystalline N-vinylcarbazole. The x-ray dose was 112 kR applied at a rate of 28 kR/hr, at temperatures of 50 to 59°C. The average polymerization degree was determined and compared with conversion. The time dependence of the polymerization was analyzed and the chain propagation and termination rate constants determined. (D.L.C.)

6635 MECHANISM OF RADIATION INITIATED SOLID STATE CYCLOPOLYMERIZATION OF CERTAIN DIMETHACRYLIMIDES. Butler, G. B.; Myers, G. R. (Univ. of Florida, Gainesville). pp 153-6 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiado (1969).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

The solid-state polymerization of N-isobutyrylmethacrylamide, dimethacrylamide, N-methyldimethacrylamide, and N-phenyldimethacrylamide was initiated by gamma rays at doses of 13 Mrad (at a rate of 0.5 Mrad/hr) and 91 Mrad (1.4 Mrad/hr). The results were compared with free-radical solution polymerization. The structures of the polymers were determined by examining their ir and NMR spectra. (D.L.C.)

6636 RADIATION PREPARATION OF WOOD PLASTIC COMBINATIONS ON THE BASIS OF WOOD-POLYESTER RESINS. Pesek, M.; Jarkovsky, J.; Pultar, F. (Inst. for Research, Production, and Uses of Radioisotopes, Prague). pp 211-15 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiado (1969).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

Two commercial unsaturated polyester resins were used: CHS Polyester 104 (normal orthophthalic type), and CHS Polyester 115 (higher unsaturation and unlimited miscibility with styrene). Beech wood was impregnated with the resins and then irradiated by ^{60}Co γ rays at a rate of 2.4×10^5 rad/hr, up to 5 or 6 Mrad. The degree of styrene conversion and the hardness of the wood plastics were measured. The results show that curing in wood is faster than of the resin alone, with doses of 1 to 1.25 Mrad being sufficient; the 0.02% hydroquinone inhibitor in the commercial resins does not affect the curing dose; and if the styrene content in CHS 115 resin is increased over 50%, the dose for curing must be increased. (D.L.C.)

6637 INFLUENCE OF MONOMER VAPOR PRESSURE ON THE RADIOINDUCED GRAFT COPOLYMERIZATION OF STYRENE ON POLYETHYLENE. Goering, H.; Roloff, H.; Schwind, A. E.; Zilinski, E. (Institut fuer Hochenergiephysik, Berlin). pp 225-9 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiado (1969). (In German).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

High-pressure polyethylene foils of 30 μm thickness were irradiated in air with 1-MeV electrons. The dose amounted to 4 Mrad delivered at a dose rate of 30 krad/sec. The samples were then suspended on a tungsten spring into a grafting container filled with styrene vapor under various pressures. With increasing pressure, total grafting time decreased; thus, increasing styrene concentrations decreased the mean life time of radicals. Several aspects of the reaction kinetics were discussed. (H.B.G.)

6638 EPR STUDIES ON RADICALS FORMING IN THE RADIOCHEMICAL GRAFTING OF STYRENE IN POLYPROPYLENE. Czvikovszky, T.; Marx, R. (Faculte des Sciences, Orsay, France). pp 237-41 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiado (1969). (In French).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

Direct grafting of styrene on isotactic polypropylene films was performed with γ radiation. In most of the experiments, the EPR spectrum was obtained after irradiation. In the final series, conducted at the nuclear center Grenoble, irradiation was performed in the SILOE reactor with three burned-up uranium rods. In this case, the spectra were taken directly during grafting under irradiation. During the grafting of styrene on polypropylene, an accumulation of a polystyryl radical was observed. This radical appeared only in a very viscous medium and at relatively low temperatures. This temperature point was close to the glassy transition of polypropylene at 275°K. In the first phase of the accumulation, these radicals could disappear in a bimolecular reaction; in the final phase they are completely trapped. (H.B.G.)

6639 GRAFTING OF ACRYLIC ACID AND STYRENE ON POLYTETRAFLUOROETHYLENE FILMS PREIRRADIATED IN PRESENCE OF AIR. Derai, Gerard; Jendrychowska-Bonamour, Anna-Maria (CNRS, Bellevue, France). pp 243-6 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiadó (1969). (In French).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

Grafting kinetics were studied for acrylic acid on preirradiated poly(tetrafluoroethylene) films (PTFE). Some grafting experiments were also performed with styrene. Fragments of PTFE film of 0.1-mm thickness, weighing around 0.1 g, were irradiated with ^{60}Co γ radiation at 20°C in air. The dose rates were 137 and 200 rad/min. Grafting was performed in a temperature range from 0 to 60°C in ampules that were sealed under vacuum. The kinetics of grafting were followed by gravimetry. The grafting rate of acrylic acid was approximately 10 times that of styrene. Microscopic examination of colored sections showed that films, 50% grafted with acrylic acid, were homogenous throughout their total mass. (H.B.G.)

6640 EFFECTS OF PREIRRADIATION CONDITIONS ON THE GRAFTING OF ACRYLONITRILE ON POLY(VINYL CHLORIDE) PEROXIDE FILMS RADIOCHEMICALLY. Foex, Michele; Jendrychowska-Bonamour, Anna-Maria (CNRS, Bellevue, France). pp 247-9 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiado (1969). (In French).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

Nonplasticized films of poly(vinyl chloride) (PVC) with a thickness of 0.35 and 0.30 mm, respectively, were irradiated with γ rays of a 1000-Ci cobalt source. The dose rate ranged from 7 to 290 rad/min, and the irradiation was performed in air at 20 to 60°C. The irradiated films were placed in pyrex ampules with 10 cc of acrylonitrile, and the vacuum-sealed ampules were then heated to 80°C. The graft yield was determined as a function of time. Results showed that radiochemical peroxidation of PVC did not enter the chain reaction. Probable reactions for the formation of hydroperoxides were discussed. (H.B.G.)

6641 RADIATION GRAFTING OF VINYL FLUORIDE TO NATURAL AND SYNTHETIC POLYMERS. Usmanov, Kh. U.; Yul'chibaev, A. A.; Asamov, M. K.; Baliev, A. (Research Inst. of Chemistry and Tech. of Cotton Cellulose, Tashkent). pp 251-5 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiado (1969). (In Russian).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

Purified cellulose and vinyl fluoride were caused to react under the influence of ^{60}Co radiation doses which varied from 9 to 150 R/sec and the extent of branching was studied as a function of radiation dose and solvent. The nature of the polymer used as a base was also investigated by replacing cellulose with poly(vinyl chloride), polystyrene, poly(tetrafluoroethylene), and poly(methyl methacrylate). The kinetics of weight loss in a vacuum at 220°C were also studied for selected polymer products. Vinyl fluoride grafting onto the subject polymers leads to a reduction of their solubilities in certain solvents, to an increase in their thermal stabilities, decomposition resistance, and lowered the tendency to swell. (K.S.W.)

6642 INVESTIGATION OF THE KINETICS OF THE RADIATION-CHEMICAL GRAFT COPOLYMERIZATION OF TETRAFLUOROETHYLENE ON POLYETHYLENE. Jobst, K. (Institut fuer Metallphysik und Reinstmetalle, Dresden). pp 257-63 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiado (1969). (In German).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

High-pressure polyethylene samples were enclosed in ampules and were irradiated with either ^{60}Co γ rays or 1.65-MeV electrons. Dose rates were 0.3 Mrad/hour for γ and 300 Mrad/hour for electrons. Following irradiation, gaseous monomers were added to the ampules. Between -10 and $+80$°C, the rate of grafting increased and reached a maximum at 40°C. Up to 9.1 atm, the grafting rate was directly proportional to monomer pressure. Polyethylene foils of 0.1-mm thickness were exposed to 10 Mrad and were stored for 24 hours either in air or in vacuum. Storage reduced the grafting because of recombination of radicals as shown by electron spin resonance determination. (H.B.G.)

6643 GRAFTING OF STYRENE ONTO LOW AND HIGH DENSITY POLYETHYLENE, INITIATED BY DIFFERENT METHODS. Dobo, J. (Research Inst. for Plastics, Budapest); Ranogajec, F.; Dvornik, I. pp 271-5 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiado (1969).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

The effects of type (high and low density) of polyethylene and initiation method (direct irradiation, preirradiation, and chemical) on the grafting reaction of styrene on polyethylene foils of varying thickness (0.05 to 1.0 mm) were investigated. Gamma irradiation at rates of 500 to 3000 r/hr and 20 to 60°C was used. The roles of thickness and density in the grafting reaction are discussed. It was found that greater thicknesses and rigidity lead to accelerated grafting, except at low temperatures. (D.L.C.)

6644 GRAFT COPOLYMERS BY IRRADIATION. Nikol'skii, V. G.; Danilov, E. P.; Mironov, N. A.; Karpov, V. L. (Inst. of Chemical Physics, Moscow). pp 345-50 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiado (1969). (In Russian).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

Molecular mobility of the grafted systems styrene-polyethylene and acrylonitrile-polyethylene was studied by means of radiothermoluminescence. The grafted polymers were synthesized by: ^{60}Co radiation on polyethylene film in the presence of the vapor of the monomer under pressure (20°C); irradiation of the film in a vacuum, with subsequent exposure to the monomer; treatment of the polyethylene surface with benzoyl peroxide, with subsequent exposure to the monomer at 80°C. Thermoluminescence of the products was recorded as the temperature was raised from 77 to 280°K at the rate of 12°/min. Luminescence maxima were correlated with the temperature of vitrification. (K.S.W.)

6645 MOLECULAR WEIGHTS OF GRAFTED POLYSTYRENE ONTO γ-PREIRRADIATED CELLULOSE DIACETATE. Munari, S.; Tealdo, G.; Rossi, C. (Univ., Genoa). pp 351-7 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiado (1969).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

The behavior of molecular weights of polystyrene grafts on preirradiated cellulose diacetate was studied. The grafting of styrene onto cellulose diacetate was kinetically followed and particular attention was paid to the polystyrene molecular weight behavior. The molecular weight was evaluated with the same polymer fractions obtained by acid hydrolysis of the grafted copolymer. From the experimental results, it appeared that the grafted chain molecular weight is completely controlled by the physical properties of the polymeric matrix either during a "bulk" or a "front" grafting. (auth)

6646 RADIATION-INDUCED GRAFT-POLYMERIZATION OF METHYL METHACRYLATE ON FLAKY GLASS SURFACE. Higashide, Fukuji; Kanazawa, Yoshiko (Shizuoka Coll. of Pharmaceutical Science, Japan). pp 359-62 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiado (1969).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

A study was made of the mechanism of grafting of methyl methacrylate (MMA) on flakes of aluminosilicate glass previously treated with $K_2Cr_2O_7-H_2SO_4$ solution. The flakes, 3 to 5 μ thick, were irradiated with ^{60}Co γ rays in ampoules, MMA added, and ESR spectra were taken at various steps in the process. The ESR spectra were found to exhibit the signal of the poly-MMA radical. DTA analyses were made of the grafted glass and of glass coated with poly-MMA. An estimate was made of the spin concentration of the radical. (D.L.C.)

6647 RADICAL AND RADIATION INDUCED GRAFTING OF SOME SYNTHETIC HIGH POLYMERS WITHIN THE TEMPERATURE RANGE OF THEIR GLASS TRANSITION. Schamberg, E.; Hoigne, J. (INRESCOR AG, Zurich). pp 363-6 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiado (1969).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

A study was made of the temperature dependence of radical and radioinduced grafting of monomers on high polymers. The monomers used were itaconic acid, acrylamide, 4-vinylpyridine, and styrene. The polymers were poly(ethylene terephthalate) (terylene) fabric, polyamide-6 (Bodanyl) yarn, polyamide-6,6 (nylon-6,6) fabric, modified polyacrylonitrile (Dralon) fabric, and polypropylene fabric. The grafting was induced by either gamma-ray or electron irradiation, or by peroxides (dibenzoyl peroxide and dimethylaniline). The results show that the grafting yield reaches its maximum in the glass transition area in all cases. This effect is not influenced by monomer, solvent, or grafting method. (D.L.C.)

6648 DIELECTRIC PROPERTIES OF THIN ORGANOSILICON FILMS AND THE INFLUENCE OF γ RADIATION ON THEIR STRUCTURE. Tkachuk, B. V.; Perova, L. V.; Kilotyrkin, V. M. Vysokomol. Soedin., Ser. A; 13: No. 4, 828-32(Apr 1971). (In Russian).

The dependence of the dielectric properties of polysiloxane films on the polymerization conditions was studied. It was shown that ϵ and tg δ are independent of the period of polymerization and by increasing the density of current discharge, the dielectric permeability also increases. A study of the temperature dependence of capacitance and tg δ showed that in the range of low temperatures polymeric films prepared from methylsiloxanes have a maximum relaxation value of tg δ. If the zone discharge is carried out in an argon atmosphere the relaxation maximum shifts to higher temperature values. The influence of γ radiation on the structure of ultrathin (0.5 to 2 mm) silicon organic polymer films, obtained from hexamethyldisiloxane and ethyl (vinyl, ethynyl) silanes having a general formula $(C_2H_5)_3$ SiR, where R = CH_2CH_3. CH = CH_2, C = CH) was studied by ir spectroscopy on the surface of aluminum exposed to a glow discharge. It was found that polymer films γ-irradiated up to doses of 250 Mrad do not undergo any structural changes. Doses of 250 to 400 Mrad bring about extra cross-linking of macromolecules as the result of the breaking off of hydrogen atoms and organic groups, after which the polymer becomes more cross-linked. (auth)

Radiolysis

Refer also to abstracts 6981, 7136, and 7733.

6649 (FRNC-TH-93) APPARATUS FOR IRRADIATING LIQUIDS BY HEAVY PARTICLES: RADIOLYTIC DECOMPOSITION OF ETHANOL BY 1-MeV PROTONS. Sibaud, Serge (Bordeaux Univ. (France)). 1971. 75p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The radiolysis of water-ethanol mixtures in the presence of nitrate was studied using 1-MeV protons from a particle accelerator. An apparatus was developed which utilizes Faraday cages to achieve a high accuracy and allows the irradiations to be carried out rapidly. Measurements were made to determine the role of the electron in absolute alcohol for a high linear energy transfer (LET). An absence of a free electron yield in these solutions was demonstrated, the total ionization yield was concluded to be of the order of 3. The heterogeneous formation of butanediol and acetaldehyde by competition between the 2 $CH_3CHOH \rightarrow (CH_3CHOH)_2$ and $H + CH_3CHOH \rightarrow H_2 + CH_3CHO$ reactions was demonstrated. The oxidation-reduction and mass balances effected demonstrate the existence of an excited species. (France)

6650 (PRNC-150) GAMMA RADIOLYSIS OF HETEROCYCLIC MOLECULES. Progress Report No. 5. Grimison, A. (Puerto Rico Nuclear Center, Mayaguez). Jul 1971. Contract AT(40-1)-1833. 21p. Dep. NTIS.

Research progress is reported on the γ radiolysis of heterocyclic molecules in the following areas: assignment of radical spectra; luminescence spectra after gamma radiolysis; scattering of low-energy electrons by molecules; and photoionization cross section calculations. (D.H.M.)

6651 (UCRL–20426, pp 259-63) RADIATION CHEMISTRY. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1971.

From Nuclear chemistry.

Research progress is reported in radiation chemistry in the following areas: reductive deamination in the radiolysis of oligopeptides in aqueous solution and in solid state; radiolytic oxidation of the polypeptide main chain in dilute aqueous solution; and radiolytic cleavage of the peptide main chain in concentrated aqueous solution; energy level of excited-molecule intermediates. (D.H.M.)

6652 COMPETITION FOR e^-_{aq} BETWEEN SEVERAL SCAVENGERS AT HIGH CONCENTRATIONS AND ITS IMPLICATIONS ON THE RELEVANCE OF DRY ELECTRONS IN THE RADIATION CHEMISTRY OF AQUEOUS SOLUTIONS. Peled, E.; Czapski, G. (Hebrew Univ., Jerusalem). J. Phys. Chem.; 75: No. 23, 3626-30(11 Nov 1971).

The relative rate constant for the reactions of e^-_{aq} with H^+ compared to Cd^{2+}, Zn^{2+}, and acetone was measured as a function of concentrations up to 2 M. The results show either that $k_{e^-_{aq}+H^+}/k_{e^-_{aq}+Cd^{2+}}$ and $k_{e^-_{aq}+H^+}/k_{e^-_{aq}+acetone}$ decrease at high concentrations or that alternatively the ratio of rates is constant, but the yields of e^-_{aq} ($G(e^-_{aq})$) decrease in these concentrated solutions. The results are related to the time dependence of the above-mentioned ratios of the rate constants, as postulated by Schwarz, and to the dry-electron concept proposed by Hamill. A definite decision cannot be made at this stage with respect to the relative importance of the two alternatives. (auth)

6653 BEHAVIOR OF THE SOLVATED ELECTRON IN ETHANOL–n–HEXANE MIXTURES. Brown, Bruce J. (Univ. of New South Wales, Sydney); Barker, Norman T.; Sangster, David F. J. Phys. Chem.; 75: No. 23, 3639-40(11 Nov 1971).

The yield and decay of the solvated electron were measured spectrophotometrically for the range of ethanol–n-hexane mixtures using 3.5 μsec pulses of 1-MeV electrons. Results show that dilution of ethanol with n-hexane down to $D_s = 1.8$ does not produce an appreciable shift in wavelength for the maximum of solvated electron absorption. There is, however, a decrease in the spectral absorption of the electron with a decrease in ethanol concentration. It was concluded that electron solvation in ethanol–n-hexane mixtures appears not to be simply a function of the static dielectric constants. A constant half-life of 3.2 ± 0.3 μsec was found for the decay over the initial 4 μsec after pulse shut-off for the range of concentrations 2 to 100 mole % ethanol. This, together with there being no shift in the position of the absorption spectrum maximum, is interpreted to suggest that the electron is trapped in basically the same type of potential well, the mechanism of reaction remaining virtually independent of the n-hexane concentration. (D.H.M.)

6654 OPTICAL ABSORPTION MEASUREMENTS OF α-HYDRONAPHTHYL RADICAL PRODUCED IN NAPHTHALENE BY ELECTRON-BEAM IRRADIATION AND HYDROGEN-ATOM BOMBARDMENT. Akasaka, Youichi; Murakami, Kouichi; Masuda, Kohzoh; Namba, Susumu (Osaka Univ.). Mol. Cryst. Liquid Cryst.; 15: No. 1, 37-47(Oct 1971).

Measurements were made on the optical absorption of a naphthalene single crystal irradiated with an electron beam and of naphthalene powder bombarded with hydrogen atoms, both at room temperature. The optical bands at 380 mμ and 540 mμ observed for both samples were attributed to α-hydronaphthyl radicals by the comparison of annealing behaviors of optical absorption bands with that of the ESR signal of this radical. (auth)

6655 TRIVALENT COPPER. II. A PULSE RADIOLYTIC STUDY OF THE FORMATION AND DECOMPOSITION OF AMINO COMPLEXES. Meyerstein, D. (Nuclear Research Centre-Negev, Beer-Sheva, Israel. Argonne National Lab., Ill.). Inorg. Chem.; 10: No. 10, 2244-9(Oct 1971).

The effect of amino ligands on the radiolytic induced formation and decomposition of trivalent copper complexes was studied. The spectra of the Cu(III) complexes with ammonia, ethylenediamine(en), and different amino acids were measured. The specific rates of oxidation of $Cu(NH_3)_4^{2+}$ by $\cdot NH_2$ radicals and the complexes of Cu^{2+} with ethylenediamine and different amino acids by ·OH radicals were determined. The $Cu^{III}(NH_3)_n$ complex decomposes via a second-order reaction. The $Cu^{III}(en)_2$ complex also decomposes via a second-order reaction. The specific rate of the latter reaction increases with increasing pH from $2k = 5.5 \times 10^5\ M^{-1}\ sec^{-1}$ at pH 5.8 to $2k = 3.9 \times 10^7\ M^{-1}\ sec^{-1}$ at pH 11.6. It is suggested that this increase is due to the formation of ·OH radicals as an intermediate in the decomposition reaction in alkaline solutions. All the amino acid complexes of Cu(III) decompose via a first-order reaction with a specific rate of (1 to 8) $\times 10^3\ sec^{-1}$. It is suggested that the first step in the latter reaction is an intramolecular electron transfer from the carboxylic group to the central copper atom. The specific rate of the reaction $Cu(III)_{aq} + Cu^{II}gly \rightarrow Cu^{2+}_{aq} + Cu^{III}gly$ was measured: $k = 8.1 \times 10^7\ M^{-1}\ sec^{-1}$. (auth)

6656 PULSE RADIOLYSIS OF AQUEOUS ALKALINE SULFITE SOLUTIONS. Zagorski, Z. P.; Sehested, K.; Nielsen, S. O. (Danish Atomic Energy Commission, Risoe). J. Phys. Chem.; 75: No. 23, 3510-17(11 Nov 1971).

$G(-O_2)$ was measured polarographically in 1 N sodium hydroxide solutions with different concentrations of sulfite and oxygen and at different dose rates. A mechanism for the chain oxidation of sulfite is proposed. The SO_3^- radical formed in the reaction $O^- + SO_3^{2-}$ reacts with oxygen and forms a radical SO_5^-, which reacts with sulfite and yields sulfate and O^-. The O^- radical is the chain carrier. The study showed that O_2^- does not react with sulfite, but O_3^- does, and the rate constant was determined to be $k(SO_3^{2-} + O_3^-) = (3.5 \pm 1.0) \times 10^4\ M^{-1}\ sec^{-1}$. The spectrum of the SO_3^- radical was obtained in a N_2O-saturated solution giving a λ_{max} 260 nm and a molar absorptivity $\epsilon_{260} = 1300 \pm 200\ M^{-1}\ cm^{-1}$. The rate constant of the O^- reaction with sulfite was determined from the competition with oxygen. On the basis of $k(O^- + O_2) = 3 \times 10^9\ M^{-1}\ sec^{-1}$, we obtained $k(O^- + SO_3^{2-}) = (2.5 \pm 0.5) \times 10^8\ M^{-1}\ sec^{-1}$. Also in N_2O solutions a chain oxidation of sulfite took place yielding G values of several thousands. This means that SO_3^- reacts with N_2O, yielding O^-, and the rate constant was found to be $k(SO_3^- + N_2O) = (3.5 \pm 1.0) \times 10^7\ M^{-1}\ sec^{-1}$. The e^-_{aq} reacts with sulfite in Ar-saturated solutions with a rate constant $k(e^-_{aq} + SO_3^{2-}) \leq 1.5 \times 10^6\ M^{-1}\ sec^{-1}$. (auth)

6657 RADIOLYSIS OF FERROUS IONS IN SULFURIC ACID SOLUTION AT HIGH INTENSITY. Muller, J. C.; Ferradini, C. (Centre de Recherches, Ivry, France). Radiochem. Radioanal. Lett.; 7: No. 4, 205-11(15 Aug 1971). (In French).

Anaerobic sulfuric acid solutions of ferrous ions were irradiated with 2-MeV electrons at an intensity of $2 \times 10^{27}\ eV/cm^{-3}/sec^{-1}$. The yield G(Fe(III)) for 10^{-2}M ferrous ion in 0.4M sulfuric acid is equal to 1.66 and increases with the concentration of ferrous ion. At pH = 2.5, G(Fe(III)) = 1.6 and is independent of ferrous ion concentration for Fe(II) < 1M. (auth)

6658 TRACK EFFECTS IN SEVERAL POLYMERS WITH DYE ADDITIVES. Zverev, A. B.; Lavrentovich, Ya. I.; Kabakchi, A. M. (Inst. of Physical Chemistry, Kiev). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 2, 132-5(Mar-Apr 1971).

Translated from Khim. Vys. Energ.; 5: No. 2, 153-7(Mar-Apr 1971).

The influence of track effects, which depend on the value of the linear transfer of energy (LET) of radiation, on the radiation-chemical transformations of crystal violet (CV) in poly(vinylchloride) (PVC) and 1,4-diaminoanthraquinone (DAAQ) in poly(methylmethacrylate) (PMMA) was studied to explain the nature of the initial stages of the radiolysis of polymers. The LET value varied from 0.2 to 90 keV/μ by using ^{60}Co γ-irradiation, 14-MeV deuterons, and 28-MeV α-particles. The dyes were introduced into the polymer films in concentrations of the order of 10^{-3}M. It is shown that CV in PVC is decolorized under the influence of the HCl which is evolved during radiolysis of the polymer with a radiation yield of 0.32 molecule/100 eV. No LET effect on this process was detected. Irradiation of colored PMMA showed that DAAQ is reduced to the leuco form by the H atoms and methyl radicals formed during radiolysis of the polymer. It was established that the radiation yield in the reduction of DAAQ in PMMA decreases with increasing LET value. (auth)

6659 ABSORPTION COEFFICIENT OF ELECTRONS CAPTURED IN ALCOHOLS AT 77°K. Sinits'ina, Z. A.; Bagdasar'yan, Kh. S. (Inst. of Physical Chemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 2, 121-3(Mar-Apr 1971).

Translated from Khim. Vys. Energ.; 5: No. 2, 140-3(Mar-Apr 1971).

Various alcohols were subjected to γ-irradiation in a planar quartz microvessel at 77°K. The optical density of the captured electrons was measured at the same temperature and the EPR spectrum was recorded. The following $\epsilon G(e^-)$ values were obtained from the optical measurements: 1.5×10^{-4}, 0.95×10^{-4}, 1.0×10^{-4}, and 1.35×10^{-4}, respectively, for ethanol, methanol, methanol + 5% H_2O, and isopropyl alcohol. The overall yields of the paramagnetic particles in ethanol, methanol, and isopropyl alcohol were 8.25, 6.45, and 9.8, respectively. The yields of captured electrons in the same alcohols were 3.55, 2.25, and 3.6, respectively. The electron absorption coefficients for all the alcohols were close to 4×10^3 liter/mole · cm. (auth)

6660 ENERGY TRANSFER IN THE RADIOLYSIS OF MIXTURES OF HYDROGEN SULFIDE AND ETHYLENE. Dzantiev, B. G.; Umukovich, M. S.; Shishkov, A. V. (Inst. of Chemical Physics, Moscow). High Energy Chem. (USSR) (Engl. Transl.): 5: No. 2, 150-1(Mar-Apr 1971).

Translated from Khim. Vys. Energ.; 5: No. 2, 172-3(Mar-Apr 1971).

The dependence of H_2 yield on composition of the $H_2S-C_2H_4$ system was studied for large C_2H_4 concentrations. The G^i/G^0-G^i vs $P_{H_2S}/P_{C_2H_4}$ curve was found to be linear up to 80% C_2H_4. This can be explained as due to excitation energy transfer from C_2H_4 molecules to H_2S, resulting in its dissociation. This is possible because C_2H_4 has a 7.7-eV level, which is close to the levels of H_2S. This is confirmed by the linear dependence of the acetylene yield on the H_2S pressure. (D.L.C.)

6661 RADIOLYSIS OF THE PROPYLENE–NITROGEN SYSTEM. FORMATION OF NITRILES. Dzantiev, B. G.; Pavlova, S. U.; Shishkov, A. V. (Inst. of Chemical Physics, Moscow). High Energy Chem. (USSR) (Engl. Transl.): 5: No. 2, 152-3 (Mar-Apr 1971).

Translated from Khim. Vys. Energ.; 5: No. 2, 173-4(Mar-Apr 1971).

The formation of acetonitrile in the γ-radiolysis of a gaseous 1 : 1 mixture of propene and N_2 at 300°C, catalyzed by HCl. The dose rate was 200 rad/sec, and the integral dose was 135 Mrad. In the absence of HCl, the acetonitrile yield was $G = 0.08 \times 10^{-2}$; it increased with HCl, reaching 3.7×10^{-2} at 11 to 12% HCl. A possible reaction mechanism is given. (D.L.C.)

6662 MEASUREMENT OF YIELD OF CHARGED PARTICLES FORMED UPON IMPULSE RADIOLYSIS IN LIQUID METHYL ALKYL KETONES. Vannikov, A. V.; Mal'tsev, E. I. (Inst. of Electrochemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.): 5: No. 2, 154-5(Mar-Apr 1971).

Translated from Khim. Vys. Energ.; 5: No. 2, 174-5(Mar-Apr 1971).

Acetone and 2-butanone were irradiated with pulses of fast electrons, and the subsequent current impulses were measured. The yield of free charged particles (G_{fc}) was determined from the maximum amplitude of the current impulses. The experimental G_{fc} vs temperature curve for 2-butanone agrees with that calculated using the static dielectric permeability, but not that using the high-frequency dielectric permeability. (D.L.C.)

6663 PULSE RADIOLYSIS OF AQUEOUS SOLUTIONS OF PYRIMIDINE BASES IN THE PRESENCE OF OXYGEN. URACIL SOLUTIONS. Fel, N. S.; Zaozerskaya, L. A.; Dolin, P. I. (Inst. of Electrochemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 2, 164-5(Mar-Apr 1971).

Translated from Khim. Vys. Energ.; 5: No. 2, 182-3(Mar-Apr 1971).

Short-lived products were studied in the pulse radiolysis of 10^{-3}M neutral aqueous solutions of uracil. In the absence of O_2, the 380-nm spectrum of the pyrimidyl radical was observed, but when O_2 was present, the pyrimidyl radical was not observed even 1 μsec after the end of a pulse. Instead, a new radical is observed, with a spectral maximum at 300 nm and a calculated molar extinction coefficient of $280 \pm 70\ M^{-1}cm^{-1}$. The reaction of the pyrimidyl radical with O_2 was measured using N_2-O_2 mixtures; its rate constant was determined to be $1.6 \pm 0.5 \times 10^{9}M^{-1}sec^{-1}$. (D.L.C.)

6664 PULSE RADIOLYSIS STUDIES OF NEUTRAL AQUEOUS SOLUTIONS OF DEOXYRIBOSE AND PYRIMIDINE NUCLEOSIDES (THYMIDINE). OH RADICAL REACTIONS. Fel, N. S.; Zaozerskaya, L. A.; Dolin, P. I. (Inst. of Electrochemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 2, 166-7 (Mar-Apr 1971).

Translated from Khim. Vys. Energ.; 5: No. 2, 184-5(Mar-Apr 1971).

The absorption spectra of short-lived products (10 μsec after pulse) was studied for pulse radiolysis of deoxyribose (DOR) solutions saturated with N_2O or He. Extinction coefficients at 260 and 370 nm were determined to be 525 and 24 for OH + DOR products in N_2O-saturated solutions, and 1450 and 164 for e_{aq}^- + DOR products, respectively. Thus, the OH + DOR products have practically zero absorption at ≥370 nm, and alterations in the base and sugar parts of a nucleoside can be followed separately in the spectrum. The spectra of irradiated N_2O-saturated thymine and thymidine solutions were compared and found to be identical. (D.L.C.)

6665 TEMPERATURE REGIONS IN WHICH ELECTRONS AND FREE RADICALS ENTRAPPED IN GLASSY POLAR SYSTEMS γ-IRRADIATED AT 77°K ARE DESTROYED. Makarov, I. E.; Ershov, B. G.; Pikaev, A. K. (Inst. of Physical Chemistry, Moscow). High Energy Chem. (USSR) (Engl. Trans.); 5: No. 2, 170-2(Mar-Apr 1971).

Translated from Khim. Vys. Energ.; 5: No. 2, 187-9(Mar-Apr 1971).

A study of the temperature regions in which entrapped electrons and radicals are destroyed (T_e^- and T_R), was made in order to compare with the phase transitions. The thermogram and the kinetics of the change in optical density or EPR signal were simultaneously recorded on heating. 10M NaOH in H_2O, 10M NaOD in D_2O, methanol, ethylene glycol, glycerol, and their aqueous solutions, and aqueous sucrose solutions were used. The T_e^- for ethylene glycol, methanol, their aqueous solutions, and alkali solutions coincide with the first phase transition, while the T_e^- for the glycerol and sucrose solutions is lower. T_R in methanol solutions takes place close to the second phase transition (recrystallization), but this is an exception. (D.L.C.)

6666 REACTIVITY OF EXCITED STATES IN CUMENE LIQUID AND GLASS AT LOW TEMPERATURES. Richards, J. T. (Univ. of Salford, Eng.); Thomas J. K. J. Chem. Phys.; 55: No. 8, 3636-41(15 Oct 1971).

Excited singlet and triplet states of cumene (isopropylbenzene) were produced in cumene liquid at 23 and −78°C, and in cumene glass at 77°K, by short 12-nsec pulses of 3-MeV electrons. In the presence of added solutes such as anthracene and naphthalene, singlet and triplet states of these compounds were also observed. The spectra of the short-lived species were recorded by the pulse radiolysis technique and these are discussed. The rates of energy transfer from both cumene singlet and triplet states to added solutes at 77°K were investigated. The rate of singlet energy transfer from cumene to naphthalene was found to be $k_3 > 3 \times 10^{-12}M^{-1} \cdot sec^{-1}$ while the rate of triplet energy transfer to naphthalene was much slower, $k_2 = 5.7 \times 10^{8}M^{-1} \cdot sec^{-1}$. The lifetime of the triplet state of cumene at 77°K under the pulse conditions used was 2.8 μsec. The nature of the processes leading to the excited states is briefly discussed. (auth)

6667 FREE RADICALS IN PYRIMIDINES: ESR OF X-IRRADIATED SINGLE CRYSTALS OF BARBITAL (5,5-DIETHYLBARBITURIC ACID). Haak, Richard; Benson, Brent (Southern Illinois Univ., Carbondale). J. Chem. Phys.; 55: No. 8, 3693-7 (15 Oct 1971).

X-irradiated single crystals of one polymorph of 5,5-diethylbarbituric acid show ESR spectra characteristic of a radical formed by abstraction of an ethyl group from $C_{(5)}$ of the pyrimidine ring. The principal values of hyperfine coupling are $A_A = 13.2$, $A_B = 11.4$, $A_C = 10.1$ G, and the principal values of the spectroscopic splitting factor are $g_u = 2.0052$, $g_v = 2.0041$, and $G_w = 2.0023$. The spin density on $C_{(5)}$ was determined to be approximately 0.4 with the remainder delocalized onto $O_{(4)}$ and $O_{(6)}$. All barbituric acid derivatives studied previously formed radicals via a variety of mechanisms that also leave the major site of unpaired electron density at $C_{(5)}$. This is also a preferred site for other pyrimidines. The unpaired spin density on $C_{(5)}$ in the barbituric acid derivatives shows a large dependence on the substituent group on $C_{(5)}$, with values of 0.4 for ethyl, 0.5 for hydroxyl, and 0.7 for hydrogen. (auth)

6668 CONCENTRATION DEPENDENT RELAXATION TIME STUDIES OF N_2^- IN X-IRRADIATED SODIUM AZIDE. Ford, Bryce; Gelerinter, Edward (Kent State Univ., Ohio). J. Chem. Phys.; 55: No. 8, 3660-3(15 Oct 1971).

The concentration dependence of the relaxation time of N_2^- in sodium azide was studied using paramagnetic resonance at 4.2°K. The relaxation rate was found to be independent of defect concentration within the experimental error of the saturation technique employed. The relaxation time product, T_1T_2, displayed the same strong anisotropy at K band (23 GHz) as was previously reported at X band. With the crystal platelet parallel to the static magnetic field, $T_1T_2 = 0.5 \times 10^{-12}\ sec^2$, and with the crystal platelet perpendicular to the static field, $T_1T_2 = 1.6 \times 10^{-12}\ sec^2$. The concentration was shown to be linear with irradiation time over the temporal range of interest by employing optical studies. These experiments indicate that the dominant relaxation mechanism is intramolecular in nature. (auth)

6669 RADIOCHEMICAL POLYMERIZATION OF METHACRYLIC ACID IN BULK. Chapiro, A.; Nguyen-Thy-Tuyet-Hao (Centre National de la Recherche Scientifique, Meudon, France). J. Chim. Phys.; 68: No. 7, 1070-2(Jul 1971). (In French).

The polymerization of methacrylic acid in bulk proceeds in precipitating medium like the corresponding reaction with acrylic acid, but the kinetic features of these processes are very different. The conversion curves of methacrylic acid are linear whereas those of acrylic acid are auto-accelerated; the dose-rate exponents are 0.65 and 0.8, respectively; the post-polymerization is much less pronounced with methacrylic acid. The absolute polymerization rate is smaller for methacrylic acid and the resulting polymer does not seem to exhibit any stereoregular structure. The association of methacrylic acid molecules by hydrogen bonds does not lead to an orientation of the double bonds which would favor chain propagation. (France)

6670 EFFECT OF CHARGED PARTICLE SCAVENGERS OF THE γ-RADIOLYSIS OF 2,2,4-TRIMETHYLPENTANE (ISOOCTANE). Muratbekov, M. B.; Zatonskii, S. V.; Saraeva, V. V. (Moscow State Univ.). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 2, 116-20(Mar-Apr 1971).

Translated from Khim. Vys. Energ.; 5: No. 2, 134-9(Mar-Apr 1971).

The effects of additions of nitrous oxide, an electron scavenger, and ammonia, a proton scavenger, on the γ-radiolysis of isooctane have been investigated. It was concluded from the results that both free radicals and stable products are formed on decomposition, by C–C bond rupture, of secondary excited molecules produced by ion–electron neutralization. Atomic hydrogen and isooctyl radicals are formed mainly from secondary excited molecules, and "molecular" isooctenes from primary excited molecules. The radiolysis of isooctane gives appreciable amounts of molecular ions not transferring a proton to ammonia. It is suggested that the charge on these ions is localized on a quaternary carbon atom. (auth)

6671 INTERACTION OF ELECTRONS WITH MONOMERS IN THE RADIOLYSIS AND PHOTOLYSIS OF ETHANOL. I. METHYL METHACRYLATE. Vasil'ev, V. G.; Verein, N. V.; Ozerova, G. A.; Piskunov, A. K. (Inst. of Physical Chemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 2, 108-12 (Mar-Apr 1971).

Translated from Khim. Vys. Energ.; 5: No. 2, 125-30(Mar-Apr 1971).

A study was made of the mechanism of the interception of the electrons of ionization by vinyl monomers and the origin of the H atoms added by them in the case of γ-radiolysis and sensitized photolysis of ethanol. The initial stages of these processes were investigated by the EPR method at 77°K in vitreous ethanol, using tetramethyl-para-phenylenediamine as the sensitizer, deuteroethanols of three types, and additions of methyl methacrylate at a concentration of 0 to 1M. The results show that the hydrogen atom added to the double bond of the monomer comes from the OH group of ethanol in both processes. It was found that there is a competition for interception of the electron formed during ionization between the ethanol traps and the monomer–ethanol complexes. At a monomer concentration of $7 \cdot 10^{-3}$M, half the electrons are captured by monomer traps. This corresponds to a probable distance of 33 Å from the amine molecule to the monomer trap. If each encounter of an electron with such a trap ends in its capture, this distance should be equal to the probable range of the electron in the matrix. In the case of photoannealing ("bleaching") of solutions containing molecules and radicals of the monomer and stabilized electrons, liberated by photons from the ethanol traps, the electrons react with the neighboring ethanol molecules, but not with the monomer, although the monomer traps intercept the electrons formed during ionization far more effectively than the ethanol traps. (auth)

6672 REDUCTION OF COPPER(II) IN FUNGAL LACCASE BY HYDRATED ELECTRONS. Pecht, I. (Weizmann Inst. of Science, Rehovoth, Israel); Faraggi, M. Nature (London) New Biol.; 233: No. 38, 116-18(22 Sep 1971).

Fungal laccase is a copper oxidase containing four Cu ions per molecule of protein bound to three different sites. Redox titrations show the involvement of four electron accepting sites in the reduction phase of the oxidase. Kinetic studies suggest that a Cu(II) ion, designated type 1, having an intense absorption band at 610 nm, is the first site to accept incoming electrons, and from this ion the electron is probably transferred to the other sites by an intramolecular process. The pulse radiolysis technique was used with a view to locating the first electron accepting site and, if possible, to determine subsequent electron flow to the other electron sites. The experimental work was carried out using a linear accelerator employing electron pulses of 100 ns, giving 3×10^{-7} electron equivalents/l. Methanol was used as scavenger for H-atoms and OH-radicals, and the decay rate of the hydrated electrons in the presence of different protein concentrations was followed at 550 nm. The decay rate of the 610 nm Cu(II) ions was also followed, and values for specific rate constants are tabulated. Results confirmed that the type 1 Cu(II) of laccase is the first specific electron accepting site in the enzyme to be reduced. In spite of the exceptionally large difference of redox potential, however, the type 1 Cu(II) ions do not undergo direct reduction by the hydrated electrons; the latter appear to react primarily with amino acid residues of the protein, and most likely with those exposed on the surface. (UK)

6673 REACTIONS IN THE HOT-ZONE THERMAL NEUTRON IRRADIATED PHOSPHATES. Anselmo, V. C.; Summers, H. V. (New Mexico Highlands Univ., Las Vegas). Inorg. Nucl. Chem. Lett.; 7: No. 11, 1087-9(Nov 1971).

Complex phosphates formed in thermal-neutron-irradiated ammonium orthophosphate, orthophosphite, and hypophosphite were studied with a view to finding a relationship between the chemical or physical environment provided by the salt and the complexity of the polyphosphate formed. The study employed the molecular mass separating capabilities of a polyacrylamide gel. Reaction mechanisms are suggested for the complex species found. (UK)

6674 REACTION OF HYDROGEN ATOMS WITH SOLID NITROSOBENZENE AND PHENYLNITROMETHANE. Trofimov, V. I.; Komleva, E. N.; Chkheidze, I. I. (Inst. of Chemical Physics, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 2, 113-15(Mar-Apr 1971).

Translated from Khim. Vys. Energ.; 5: No. 2, 131-3(Mar-Apr 1971).

The radicals which are formed during the reaction of hydrogen atoms with solid nitrosobenzene and phenylnitromethane or during the γ irradiation of these compounds, were studied by the EPR method. It is shown that the –NO group in nitrosobenzene is a stronger acceptor of H atoms at low temperatures than the phenyl ring. The C_6H_5NOH radical is the main secondary radical in the radiolysis of nitrosobenzene also. In the reactions with phenylnitromethane the hydrogen atoms are added to both the $-NO_2$ group and the phenyl ring. During the irradiation of the phenylnitromethane, the radicals are formed both with the participation of H atoms and with the rupture of the C–N bond in the molecule. (auth)

6675 STUDY OF THE INFLUENCE OF THE CHEMICAL AND SUPERMOLECULAR STRUCTURE ON RADIATION CHEMICAL PROCESSES IN SEVERAL POLYOLEFINS. Dzhibgashvili, G. G.; Slovokhotova, N. A.; Leshchenko, S. S.; Karpov, V. L. (Scientific-Research Physical-Chemical Inst., Moscow). Vysokomol. Soedin., Ser. A; 13: No. 5, 1087-96(May 1971). (In Russian).

Low-temperature radiolysis of high-density polyethylene (HDPE) and copolymers of ethylene with 7 mole % of propylene and with 3 mole % α-butylene was studied by ir-spectroscopy. It was shown that molecular structural changes take place in these polymers owing to primary radiation chemical processes. The structure of the polymer chain has an influence on these processes. In a study of post-radiation processes it was discovered that vinyl double bonds disappear during chain reactions with free radicals with the formation of intermolecular bonds. It was shown that conjugated dienes are formed both during primary radiation chemical processes as well as during post-radiation reactions due to the migration of the free radical center along the chain. It was established that intramolecular cross-links, which bring about the formation of cyclic structures, are produced during primary radiation chemical processes. Post-radiation reactions do not play a role in their formation. On this basis it was suggested that intramolecular cross-linking occurs by a ionic mechanism. It was shown that HDPE greatly tends to form intramolecular bonds. More regular surface structure of polymer chain-folded crystals promotes effective intramolecular cross-linking. (auth)

6676 CONCENTRATION OF RADICALS IN γ-IRRADIATED POLY(ETHYLENE TEREPHTHALATE). Rogowski, Robert S. (Langley Research Center, Hampton, Va.). J. Polym. Sci., Part A-2; 9: No. 10, 1911-14(Oct 1971).

Results of an ESR spectral study of γ-irradiated poly(ethylene terephthalate) showed that radical I (–⬡–CO–O–CH_2–$\dot{C}$H–O–CO–⬡–) accounts for 90% of the radicals in the crystalline regions and radical II (–O–CO–⬡–CO–O–) accounts for 98% of the radicals in the gross polymer. (D.H.M.)

6677 ELECTRON SPIN RESONANCE STUDY OF RADICAL FRAGMENTATION FROM POSITIVE PRIMARIES IN IRRADIATED SINGLE CRYSTALS OF UNSATURATED CARBOXYLIC ACIDS. Toriyama, Kazumi; Iwasaki, Machio; Noda, Shoji; Eda, Bunzo (Government Industrial Research Inst., Nagoya, Japan). J. Amer. Chem. Soc.; 93: No. 24, 6415-21(1 Dec 1971).

The fragmentation of the carboxyl radical formed in an irradiated single crystal of potassium hydrogen maleate was studied by electron spin resonance. It was previously found that the crystal irradiated at 77°K in the dark gives the symmetrical σ radical formed by removal of the acidic proton, where the unpaired electron occupies the antibonding orbital between the two in-plane p orbitals of the two ring oxygen atoms. It was found that this symmetrical radical converts into the asymmetric radical, where the unpaired electron is located in one of the two COO groups when the irradiated crystal is exposed to visible light at 77°K. Furthermore, prolonged exposure to visible light gives rise to the fragmentation of this radical, forming the CO_2^- ion through an intermediate radical which is assumed to be a vinyl-type radical. Since the symmetrical σ radical mentioned above is believed to be formed by the ejection of an electron followed by proton transfer to the neighboring molecule, results indicate the fragmentation path from the positive primaries in irradiated crystals of unsaturated carboxylic acids. (auth)

6678 STRUCTURE OF RADICALS FORMED BY RADIOLYSIS OF FROZEN AQUEOUS DEXTRAN SOLUTIONS. Sharpatyi, V. A.; Gol'din, S. I. (Inst. of Chemical Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Khim.; No. 6, 1367(Jun 1971). (In Russian).

Aqueous dextran solutions (6%) were frozen and irradiated at 77°K. Electron paramagnetic resonance spectra offered evidence of the presence of a stabilized electron, OH radicals, and radicals from dissolved polysaccharides. The data are detailed in tabular form with EPR interpretation. (K.S.W.)

6679 RADIOLYSIS OF THYMINE IN AERATED AQUEOUS SOLUTION. Teoule, R.; Cadet, J. (CEN, Grenoble, France). J. Chem. Soc., D; No. 20, 1269-70(20 Oct 1971).

Twenty-three products from the radiolysis of thymine in aerated aqueous solution were identified and classified in a coherent scheme. (auth)

6680 MORPHOLOGY AND STRUCTURE OF POLYOXYMETHYLENE OBTAINED BY SOLID-STATE REACTIONS. Munoz-Escalona, A.; Fischer, E. W.; Wegner, G. (Univ., Mainz). pp 103-7 of Kinetics and Mechanism of Polyreactions. Vol. IV. Budapest; Akademiai Kiado (1969).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.4).

The solid-state polymerization of trioxane and tetroxane under the influence of ^{60}Co γ rays, BF_3-ethyl ether complex, and sublimation was studied in order to characterize the morphology of the polymers. The polymers were studied using x-ray wide-angle and small-angle scattering, and electron micrographs and electron-diffraction pictures were taken. The results show that a solid-state polymerization method, applied to related substances such as trioxane and tetroxane, yields different morphological structures. (D.L.C.)

6681 RADICAL KINETICS IN VACUUM IRRADIATED POLY(VINYL CHLORIDE). Bartl, A. (Institut fuer Metallphysik und Reinstmetalle, Dresden). pp 209-14 of Kinetics and Mechanism of Polyreactions. Vol. V. Budapest; Akademiai Kiado (1969). (In German).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.5).

A study was made of the formation and disappearance of radiation-induced free radicals in poly(vinyl chloride) (PVC) under vacuum for defined conditions. The cage model for radical recombination explained decay curves satisfactorily in the range from 40 to 90°C. Purified PVC powder was placed into small glass tubes that were evacuated at 10^{-6} Torr. At ambient temperature, the samples were exposed to various doses of ^{60}Co γ radiation at a dose rate of 2.3×10^5R/hour. After radiation-induced paramagnetic centers in the glass were removed by heating, electron paramagnetic resonance determinations were made on the poly(vinyl chloride). (H.B.G.)

6682 PHOTOLYSIS AND RADIOLYSIS OF POLYVINYL ACETATE. David, C.; Borsu, M.; Geuskens, G. (Univ. Libre, Brussels). pp 221-4 of Kinetics and Mechanism of Polyreactions. Vol. V. Budapest; Akademiai Kiado (1969).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.5).

Thin films of poly-(vinyl acetate) (PVA) were irradiated in air and under vacuum with uv light of 2537 Å. An insoluble gel was formed, the amount of which increased with dose in both cases. The gelling dose was determined and the quantum yield for crosslinking calculated. This is higher when irradiation is performed in vacuum. A plot of $S + \sqrt{S}$ (S = soluble fraction) versus reciprocal dose according to the Charlesby–Pinner equation gives a straight line, the intercept of which indicates that chain scission occurs simultaneously with appreciable quantum yield. When PVA is irradiated as a powder with gamma rays under vacuum, an insoluble network is also formed. Chain scission and crosslinking yields were measured. Photolyses and radiolysis results are compared and discussed. (auth)

6683 γ-RADIATION EFFECTS ON TETRACHLOROPHTHALATE POLYESTERS IN AIR, NITROGEN, VACUUM, AND IN SOLUTIONS. Ghanem, N. A. (National Research Centre, Cairo); El-Azmirly, M. A.; Aly, Mohammed I. pp 225-30 of Kinetics and Mechanism of Polyreactions. Vol. V. Budapest; Akademiai Kiado (1969).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol. 5).

Saturated and unsaturated polyesters containing tetrachlorophthalic units were prepared, purified, and characterized. They were subjected to the influence of γ radiation in a strong ^{60}Co cell for various doses in air, in inert atmosphere, under vacuum, and in dioxane and styrene solutions. Gaseous, liquid, and solid polymeric products were examined by gas chromatography, elementary analysis, viscosity, acid value, differential thermal analysis, and infrared spectrophotometry. In the solid-state irradiation, the most pronounced effect is dehydrohalogenation especially under vacuum with a slight tendency towards chain scission. No crosslinking was observed even at elevated doses. In dioxane solution, a second-order reaction between the polymer halogen and the solvent hydrogen was observed which results in a polymer of a clearly reduced halogen content and unsaturated dioxane derivatives. There was no evidence of branching or crosslinking between the saturated polyesters and styrene; the irradiation product consisted entirely of mainly linear polystyrene and polyester of reduced halogen content. (auth)

6684 IMPORTANCE OF INTRAMOLECULAR REACTIONS IN THE COURSE OF AUTOOXYDEGRADATION OF POLYOXYETHYLENE AT 25°C. STUDY BY INDIRECT RADIOCHEMICAL PRIMING IN DILUTE AQUEOUS SOLUTION. Decker, C.; Marchal, J. (CNRS, Strasbourg). pp 231-7 of Kinetics and Mechanism of Polyreactions. Vol. V. Budapest; Akademiai Kiado (1969). (In French).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.5).

Autooxydegradation of polyoxyethylene in aqueous aerated solution was studied after radiochemical priming with γ exposure. Gas chromatography of the irradiated solution identified ten light primary products: formaldehyde, formic acid, ethylene glycol, glycolic aldehyde, ethylene glycol monoformate, ethylene glycol diformate, diethylene glycol (DEG), DEG aldehyde, DEG monoformate, and DEG diformate. Formaldehyde production was explained as monomolecular decomposition of peroxyl radicals through a mechanism comprising a hexagonal transition state. The other products resulted from a successive breakage up to three monomer sections by intramolecular attack of the macroradicals peroxyl or alcoxyl. (H.B.G.)

6685 OXIDIZING DEGRADATION OF POLYSTYRENE AT 25°C: STUDY BY INDIRECT RADIOCHEMICAL PRIMING IN DILUTE CHLOROFORM SOLUTIONS. Abadie, Marc; Marchal, Jean (CNRS-CRM, Strasbourg). pp 239-43 of Kinetics and Mechanism of Polyreactions. Vol. V. Budapest; Akademiai Kiado (1969). (In French).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.5).

Gamma irradiation of aerated solutions of polystyrene in chloroform leads to the macroradicals $PO_2^{\bullet}$ consequent to oxidation of $P^{\bullet}$ which, in turn, results from an attack on the polymer through the radicals $Cl^{\bullet}$ and $RO_2^{\bullet}$ produced by radiolysis of the solvent. This is a convenient production method for PO_0^2 with respect to the study of chemical properties of such radicals, especially at room temperature. By these means it was found that, at 25°C, a part of the PO_2^0 decomposes without measurable induction time and liberates three styrene oxidation products: benzaldehyde, epoxystyrene, and formaldehyde. The possible decomposition mechanism is discussed, especially with respect to a transitional hexagonal state. (H.B.G.)

6686 EVIDENCE, AT 25°C, FOR OXIDIZING DEGRADATION OF POLYOXYTETRAMETHYLENE, POLYPROPYLENE, AND 1,3,5-TRIMETHYCYCLOHEXANE. STUDY BY INDIRECT RADIOCHEMICAL PRIMING IN DILUTE CHLOROFORM SOLUTION. Thomassin, C.; Marchal, J. (CNRS-CRM, Strasbourg). pp 245-8 of Kinetics and Mechanism of Polyreactions. Vol. V. Budapest; Akademiai Kiado (1969). (In French).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol.5).

The use of gas phase chromatography has made it possible to demonstrate that auto-oxidation reactions are accompanied by degradation reactions giving light products by splitting of the macromolecules. This oxidizing degradation was studied by using the method of starting with γ irradiation of dilute solutions. The formation of ethylene in the case of polyoxytetramethylene and that of propylene in that of 1,3,5-trimethylcyclohexane and of polypropylene can be explained by the monomolecular mechanism of decomposition with a hexagonal transition state discovered in the laboratory in the course of work on polyoxyethylene. (tr-auth)

6687 STUDY ON THE MECHANISM OF MONOMOLECULAR DECOMPOSITION OF PEROXIDE RADICALS FORMED ON POLYOXYMETHYLENE DURING FUSED AUTOOXIDATION IN CHLOROFORM OF DILUTE AQUEOUS SOLUTION BY γ IRRADIATION AT 25°C. Gondet, J. C.; Crouzet, C.; Marchal, J. (CNRS–CRM, Strasbourg). pp 249-54 of Kinetics and Mechanism of Polyreactions. Vol. V. Budapest; Akademiai Kiado (1969). (In French).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843-(Vol. 5).

The first results were interpreted by explaining the monomolecular decomposition of the peroxyl radicals by a mechanism with a quadrangular transition state which would liberate a terminal fragment by a formic acid ester and a terminal fragment by an alpha alkoxy–alkoxyl radical spreading the oxidizing degradation. The stabilization of the alpha alkoxy–alkoxyl radical by stripping of hydrogen permitted in effect taking into account of the existence of half-formal groups determinable chemically in the recovered polymer after irradiation by evaporation of the solvent. The use of gas phase chromatography has made it possible to show that free formaldehyde exists also in irradiated solutions and the kinetics of formation show that it is a matter of the primary product of the oxidizing degradation. These new results have resulted in the elimination of the mechanism of monomolecular decomposition with the quadrangular transition state previously proposed because the hypothesis of depolymerization of the alpha alkoxy–alkoxyl radicals cannot be used to explain the formation of free formaldehyde to the advantage of the mechanism with the hexagonal transition state which has already made it possible to take into account the results obtained by starting with the oxidizing degradation of the polymer in aqueous solution at 25°C. Some very rapid secondary addition reactions of formaldehyde not dissolved in anhydrous chloroform make it possible to take the previous results into account. (tr-auth)

6688 EVIDENCE, BY RADIOCHEMICAL PRIMING IN DILUTE CHLOROFORM SOLUTION, OF OXIDIZING DEGRADATION OF POLYOXYPROPYLENE AT 25^0C. Gondet, J.-C.; Marchal, J. (CNRS–CRM, Strasbourg). pp 255-8 of Kinetics and Mechanism of Polyreactions. Vol. V. Budapest; Akademiai Kiado (1969). (In French).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843–(Vol.5).

The study by gas phase chromatography of the light products from the oxidizing radiolysis of chloroform solutions of polyoxypropylene generalizes the conclusions obtained for polyoxyethylene. The splitting of the products of the oxidizing degradation of the polymer, as well as the kinetics of formation, can be explained by a mechanism of monomolecular decomposition of the peroxyl radicals behaving as a hexagonal transition state. Beside a fragment ending with an alkoxyl radical, the decomposition of peroxyl radicals produced by secondary carbons produces a fragment terminating in a formic acid ester and a molecule of acetaldehyde and that of a radical with tertiary carbons produces a fragment ending with an acetic acid ester and a molecule of formaldehyde. The determination of the yields of the various products has made it possible to study the competition between the formations of the peroxyl radicals on the tertiary and secondary carbons. (tr-auth)

6689 INACTIVITY OF HO_2 AND O_3^- RADICALS IN PRIMING AT 25^0C OF THE AUTOOXIDATION OF POLYOXYETHYLENE IN AQUEOUS SOLUTION. Crouzet, C.; Marchal, J. (CNRS–CRM, Strasbourg). pp 259-62 of Kinetics and Mechanism of Polyreactions. Vol. V. Budapest; Akademiai Kiado (1969). (In French).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843–(Vol.5).

In a previous work (IUPAC Symposium, Prague, 1965) it was shown that the auto-oxidation of polyoxyethylene, studied by radiochemical initiation in aqueous solution at 25°C, is characterized by well-known hydroperoxidation reactions and also by reactions of oxidizing degradation explained by the monomolecular decomposition of the peroxyl macroradicals. A mechanism with a hexagonal transition state takes account of this decomposition. The kinetic scheme and the principal conclusions are given. The study of the kinetic results indicates also that the $HO_2^{\cdot}$ radicals are incapable of initiating the auto-oxidation chains of the polymer. The use of the technique of "mixing flow" gives a direct proof of the inactivity of the $HO_2^{\cdot}$ towards the ether oxide function. The reagent Ti^{3+}/H_2O_2 produces OH^- and the attack on the polymer by these radicals is manifested by the radical $P^{\cdot}$: $\sim O\dot{C}HCH_2\sim$. The reagent Ce^{4+}/H_2O_2 produces some $HO_2^{\cdot}$, and no $P^{\cdot}$ radical is formed. The study of the kinetic results shows that beyond pH ≃ 10, the yield of the oxidizing degradation decreases rapidly following a law closely related to that of the ionization equilibrium of the radical (pH ≃ 11.9). The experiments described show that the radical ions $0^{\cdot}$ are active in the absence of oxygen (the polymer is reticulated) and that there are radical ions $0_3^{\cdot}$ formed by fixation of O_2 which are inactive. (tr-auth)

6690 ELECTRON SPIN RESONANCE STUDY OF THE EFFECT OF OXYGEN IN THE RADIATION DEGRADATION OF POLYMERS. Hedvig, P. (Research Inst. for Plastics, Budapest). pp 277-80 of Kinetics and Mechanism of Polyreactions. Vol. V. Budapest; Akademiai Kiado (1969).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843–(Vol.5).

Various polymers such as poly(tetrafluoroethylene), poly(ethyleneterephthalate), poly(chlorotrifluoroethylene), polypropylene, and poly(vinyl chloride) were degraded by ^{60}Co gamma rays at different temperatures in the presence and in the absence of oxygen. The degradation was checked by mechanical stress–strain measurements and in some cases by viscometric determination of the average molecular weights. The electron spin resonance technique was also used for determining radical concentrations and structures after irradiation and subsequent thermal and radiation treatment. The results are interpreted on the basis of a scheme proposed earlier for poly(tetrafluorethylene). According to this view the excitation energy of the radiation is absorbed by the peroxy group leading to rupture of the main chain. The chain-end radicals formed this way are quickly transformed to chain-side radicals which in term are oxidized and the cycle starts over again. For some of the polymers studied, this process could be directly followed by electron spin resonance. (auth)

6691 OXIDATIVE DEGRADATION OF STABILIZED RADIATION CROSSLINKED POLYETHYLENE. Somogyi, A.; Hedvig, P.; Dobo, J. (Research Inst. for Plastics, Budapest). pp 393-6 of Kinetics and Mechanism of Polyreactions. Vol. V. Budapest; Akademiai Kiado (1969).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969). See CONF-690843–(Vol.5).

Radiation-crosslinked polyethylene (PE) is known to be very sensitive to oxidative degradation. The thermal stability and the stability of the electric properties of radiation-crosslinked polyethylene containing carbon black-type stabilizers is studied. (auth)

6692 RADIATION-INDUCED DECHLORINATION OF PENTACHLOROETHANE AND SYM-TETRACHLOROETHANE. REACTIONS OF 1,1,2,2-TETRACHLOROETHYL AND 1,2,2-TRICHLOROETHYL RADICALS. Katz, M. G.; Horowitz, A.; Rajbenbach, L. A. (Soreq Nuclear Research Centre, Yavne, Israel). Trans. Faraday Soc.; 67: No. 584, 2354-64(Aug 1971).

Pentachloroethyl, 1, 1, 2, 2-tetrachloroethyl, and 1, 1, 2-trichloroethyl radicals were produced by the reactions of radiolytically generated cyclohexyl radicals with pentachloroethane and sym-tetrachloroethane. The kinetics of the following reactions were studied: $c\text{-}C_6H_{11} + C_2Cl_5H \rightarrow c\text{-}C_6H_{11}Cl + C_2Cl_4H$ (2), $c\text{-}C_6H_{11} + C_2Cl_5H \rightarrow c\text{-}C_6H_{12} + C_2Cl_5$ (3), $C_2Cl_4H + c\text{-}C_6H_{12} \rightarrow C_2Cl_4H_2 + c\text{-}C_6H_{11}$ (4), $C_2Cl_4H \rightarrow C_2Cl_3H + Cl$ (5), $c\text{-}C_6H_{11} + C_2Cl_4H_2 \rightarrow c\text{-}C_6H_{11}Cl + C_2Cl_3H_2$ (11), $c\text{-}C_6H_{11} + C_2Cl_4H_2 \rightarrow c\text{-}C_6H_{12} + C_2Cl_4H$ (12), $C_2Cl_3H_2 + c\text{-}C_6H_{12} \rightarrow C_2Cl_3H_3 + c\text{-}C_6H_{11}$ (13), and $C_2Cl_3H_2 \rightarrow C_2Cl_2H_2 + Cl$ (14). The following rate expressions were obtained: $\log_{10}(k_2/k_3) = 1.40 \pm 0.15 - (660 \pm 230)/4.576T$; $\log_{10}(k_{11}/k_{12}) = 1.07 \pm 0.06 - (3780 \pm 120)/4.576T$; $\log_{10}(k_5/k_4)(\text{mole l}^{-1}) = 5.63 \pm 0.07 - (8100 \pm 100)/4.576T$; and $\log_{10}(k_{14}/k_{13})(\text{mole l}^{-1}) = 5.91 \pm 0.21 - (6900 \pm 400)/4.576T$. R the gas constant was taken to be 1.9872 cal K^{-1} $mole^{-1}$ and subsequent activation energies expressed in cal mol^{-1} (1 cal = 4.1855 J). (auth)

6693 RADIOLYTIC DECOMPOSITION OF CRYSTALLINE LITHIUM PERCHLORATE BY RECOIL PARTICLES. Hasegawa, Kunihiko; Yoshida, Zenko Nippon Kagaku Zasshi; 92: No. 6, 568-9(Jun 1971). (In Japanese).

The amounts of perchlorate ion decomposition and the yields of chloride, hypochlorite, chlorite, and chlorate ions in the radiolysis of the crystalline $LiClO_4$ by irradiation with ^{60}Co γ-rays and recoil tritons and α particles accompanied with ^{6}Li neutron capture, $^6Li(n,\alpha)^3H$, were determined as the function of absorbed dose and reactor temperature. The initial 100-eV yield for $LiClO_4$ decomposition by recoil particles, $G(-ClO_4^-)$, was 4.46. This value was approximately 1.5 times as large as that obtained with ^{60}Co γ rays. The yield of chloride was independent of the reactor temperature. (auth)

6694 CYTOTOXIC α,β-UNSATURATED CARBONYL SUGARS AS RADIOLYSIS PRODUCTS OF CARBOHYDRATES. Schubert, Jack; Sanders, Edward B. (Univ. of Pittsburgh). Nature (London) New Biol.; 233: No. 41, 199-203(13 Oct 1971).

Radiolysis of sugar produces α,β-unsaturated carbonyl sugars, which are found to be cytotoxic. The reported results have important implications for the safety of irradiated foods. (auth)

Radioisotope Production

Refer also to abstracts 6722 and 6723.

6695 (CEA-R-4108) PREPARATIVE ELECTROPHORESIS OF INDUSTRIAL FISSION-PRODUCT SOLUTIONS. Tret, Joel (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). Jul 1971. 79p. (In French). Dep. NTIS (U. S. Sales Only).

The use of continuous electrophoresis techniques and their applications in the preparative electrophoresis of industrial fission product solutions are discussed. An original apparatus is described; it was constructed for the investigations carried out and has proved very reliable. The experimental conditions necessary to maintain and supervise the apparatus in a state of equilibrium are examined in detail; their stability is an important factor indispensable to the correct performance of an experiment. Under the appropriate experimental conditions preparative electrophoresis can be used to prepare carrier-free radioelements of radiochemical purity (5 to 7 radioelements): ^{137}Cs, ^{90}Sr, $^{141+144}$Ce, ^{91}Y, ^{95}Nb, ^{95}Zr, and $^{103+106}$Ru. (France)

6696 PREPARATION OF HIGH-PURITY, CARRIER-FREE ^{131}Cs SOURCE FOR SPECTROSCOPIC MEASUREMENTS. Kotlinska-Filipek, B.; Myslek, B.; Stryczniewicz, K. (Inst. of Nuclear Research, Swierk, Poland). Radiochem. Radioanal. Lett.; 8: No. 3, 159-64(10 Nov 1971).

A carrier-free ^{131}Cs source of very high purity was obtained as a daughter product of ^{131}Ba. The latter was produced by the ^{130}Ba (n,γ)^{131}Ba reaction. Natural barium was irradiated in a reactor and then purified to remove ^{132}Cs and possibly ^{137}Cs isotopes present in the sample. About 15 days later ^{131}Cs was isolated and purified by ion exchange chromatography. Sources for electron spectroscopy were prepared by microcolumn technique. Other radioactive Cs isotopes and ^{131}Ba in the ^{131}Cs source measured immediately after the preparation of ^{131}Cs were found to be less than 10^{-7} per ^{131}Cs decay. (auth)

6697 ^{68}Ga LABELED COMPOUNDS FOR TOMOGRAPHIC STUDIES. Colombetti, Lelio G. (Stanford Univ., Palo Alto, Calif.); Yeh, Shin-hwa Nucl. Sci. J. (Taiwan); 8: No. 1, 21-35 (Apr 1971).

A positron emitter, ^{68}Ga, is readily obtained from a ^{68}Ge generator by complex formation with EDTA. The way to convert ^{68}Ga-EDTA into suitable compounds was found. ^{68}Ga is freed from its EDTA chelate by boiling the solution in the presence of Fe^{3+} in a strongly acidic medium. Compounds for lungs and liver studies were prepared and used, in combination with the Pho-Gamma camera, with a positron detector attachment to obtain tomographic displays of the organs in study. This allows the detection of small deep-seated lesions in the large organs. (auth)

Recoil Production and Reactions

6698 (ORO-3898-3) REACTIONS OF HIGH ENERGY RADIOACTIVE ATOMS RESULTING FROM NUCLEAR TRANSFORMATIONS IN THE SYSTEMS OF SILICON-CONTAINING COMPOUNDS. Progress Report, February 1971–January 1972. Tang, Yi-Noo (Texas Agricultural and Mechanical Univ., College Station. Dept. of Chemistry). 20 Oct 1971. Contract AT(40-1)-2898. 124p. Dep. NTIS.

Research progress is reported on: hot atom reactions with silicon-containing compounds, including recoil tritium and recoil halogen reactions with silanes, disilanes, and halosilanes; reactions of high-energy multivalent atoms, including development of studies on ^{31}Si atoms and initiation of gas-phase studies on ^{32}P atoms; and evaluation of median energy deposition after hot atom substitution reactions, consecutive decomposition following energetic substitution, computer-simulated calculations of energy-deposition spectra after hot atom substitution, energy randomization problem for unimolecular processes, and energetics of recoil halogen addition to olefins. (M.C.G.)

6699 HOT-ATOM CHEMISTRY OF ^{51}Cr ATOMS IN NEUTRON-IRRADIATED BENZENE SOLUTIONS OF TRIS-(ACETYLACETONATO)-CHROMIUM(III). Tominaga, T.; Nishi, Y. (Tokyo Univ.). Radiochem. Radioanal. Lett.; 8: No. 3, 151-7 (10 Nov 1971).

Some metal salts (iron(III) chloride, aluminum chloride, etc.) were shown to suppress the ^{51}Cr thermal reactions taking place in irradiated solutions of $Cr(acac)_3$ in benzene and in solutions of irradiated solid $Cr(acac)_3$. The use of such scavengers appears to be a useful technique for determining the primary retention in solutions or the true (or initial) retention in solids. (auth)

Radiochemistry

Refer also to abstract 6698.

6700 REACTIONS OF ACCELERATED ^{14}C WITH BENZENE. DEGRADATION OF TOLUENE AND ITS MECHANISM OF FORMATION. Lin, Tz-hong; Lemmon, Richard M. (Univ. of California, Berkeley). J. Phys. Chem.; 75: No. 23, 3524-6 (11 Nov 1971).

A study was made of the total degradation of the toluene product obtained from impinging 5000- and 4000-eV $^{14}C^+$ ions on solid benzene at −196°C. The radioactivity distribution was essentially equivalent to that of toluene obtained in carbon recoil experiments. The ring/methyl activity ratios were also determined for toluenes from irradiations at various energies down to 5 eV. While the yield of toluene decreased drastically below 100 eV, the ring/methyl activity ratio remained constant, changing only when the energy of the incident ions were lowered to 5 eV. It is suggested that bare carbon atoms, as well as CH_2, are important species leading to toluene formation. (auth)

6701 MOESSBAUER EMISSION SPECTROSCOPY OF SOME ^{57}Co-LABELLED COBALT COMPLEXES. Friedt, J. M.; Poinsot, R.; Sanchez, J. P. (CNRS, Strasbourg). Radiochem. Radioanal. Lett.; 7: No. 4, 193-203(15 Aug 1971).

The Moessbauer emission spectra of ^{57}Co-labeled cobaltocene, cobalticinium, and cobalt(II) chloride-pyridine complexes are reported. Aliovalent ions (ions with charge state different from that of the parent cobalt ion) were observed only in cobalticinium. The after-effects of the ^{57}Co electron capture decay are explained on the basis of the autoradiolysis model. (auth)

6702 RADIOCHEMICAL DETECTION OF PHOSPHATE PRECIPITATION BY CALCIUM CARBONATE. Amer, F.; Alradi, A.; Mahdy, S. (Ministry of Agriculture, Iraq). Isotope Radiat. Res.; 4: 77-83(Jun 1971).

Weighed samples ranging from 1 to 60 g of reagent-grade $CaCO_3$ were equilibrated with 100-ml volumes of 1.821 millimolar KH_2PO_4 solution to test the possibility of identifying the precipitated calcium phosphate compounds by isotopic exchange measurements with ^{32}P and ^{45}Ca. At equilibrium, about 97.6% of the phosphate was removed from the solutions regardless of the amount of $CaCO_3$ used. Accordingly, phosphorus retained by $CaCO_3$ ranged from 5511 ppM to 90.9 ppM when 1 g and 60 g $CaCO_3$ were used, respectively. Analysis of the equilibrium solutions indicated that the solubility equilibrium was governed, in all cases, by octacalcium phosphate. Isotopic exchange measurements showed that both surface phosphorus and surface calcium increased by increasing the isotopic exchange period from 2 hours to 72 hours and decreased by aging. The average molar ratio of surface calcium to surface phosphorus was 1.30 for systems retaining more than 1000 ppM phosphorus. This ratio is in close agreement with the theoretical calcium to phosphorus ratio of 1.33 for octacalcium phosphate, thereby confirming the presence of this compound as indicated by the solubility criteria. The surface calcium to surface phosphorus ratio markedly increased with decrease in the retained phosphorus due to interference from the surface calcium of $CaCO_3$. Solubility equilibrium, however, was still governed by octacalcium phosphate which presumably was forming thin coatings around the $CaCO_3$ particles. (auth)

6703 EFFECT OF TEMPERATURE ON THE CHEMICAL CHANGES ACCOMPANYING NUCLEAR ISOMERIC TRANSITION (^{121m}Te, ^{127m}Te, AND ^{129m}Te DECAY) IN CRYSTALLINE TELLURIC ACID. Bulbulian, S. (Comision Nacional de Energia Nuclear, Salazar, Mexico); Maddock, A. G. J. Chem. Soc., A: No. 18, 2810-13(1971).

The fragments formed by isomeric transition in the telluriun in telluric acid crystals were found to be not more susceptible to thermal annealing concurrent with their growth in the crystals than they are to annealing following growth at a much lower temperature. Measurements are reported for ^{121m}Te, ^{127m}Te, and ^{129m}Te. (auth)

6704 FORMATION AND CONTROL OF SAMARIUM AND YTTERBIUM CHELATE COMPLEXES USED AS RADIOPHARMACEUTICALS. Chowdhary, S. Y.; Jasz, A. (Isotope Inst., Budapest). Radiochem. Radioanal. Lett.; 8: No. 4, 225-31(5 Dec 1971).

Metal complexes of EDTA, DTPA, and HEDTA labeled with ^{153}Sm and ^{169}Yb were prepared by the exchange reaction. The formation of complexes was also studied with the aid of electrophoresis by varying the concentration of reactants. Electrophoresis was found to be the most suitable method for verifying the presence of excess complexing agent and for controlling the radiochemical purity of the complexes. (auth)

6705 GAMMA SPECTROSCOPY OF TELLURIUM ISOMERS USING A CHEMICAL SEPARATION OF THE GROUND FROM THE METASTABLE STATE. Bulbulian, S. (Comision Nacional de Energia Nuclear, Mexico City); Mondragon, A. Rev. Mex. Fis.; 20: No. 2, 97-103(1971).

The chemical effects produced by isomeric transition from the metastable to the ground state tellurium isomers in telluric acid molecules permit separation of the material into two fractions, one containing the ground state isomers only and the other containing both the ground state and metastable isomers. The gamma spectra of the ground state tellurium isomers were easily separated from those of the metastable isomers in a mixture of tellurium isotopes. This method can be of importance in the detection and separation of energy levels in pairs of isomers that meet the requirements imposed by the procedure. (auth)

Separation Processes

Refer also to abstracts 6474, 6540, 6585, 6774, 7155, and 7156.

6706 (DOCKET-406622-1) SHIRLEY BASIN URANIUM MILL. Statement of Reasons Why License to Operate Should Not Be Suspended Pending Completion of NEPA Environmental Review, Supplement. (Utah International, Inc., San Francisco, Calif.). 5 Nov 1971. 18p. Dep. NTIS.

Information is presented in support of reasons not to suspend operation of the mill pending environmental review. The additional land area that would be affected by mine wastes and mill tailings as a result of another 6 months of operation, data compiled from air and water monitoring programs, and the costs that would be incurred by licensee as a result of license suspension are discussed. (M.C.G.)

6707 (DOCKET-50332-23) BARNWELL NUCLEAR FUEL PLANT. Discussion and Findings Relating to the Suspension Pending NEPA Environmental Review. (Division of Materials Licensing (AEC), Washington, D. C.). 1 Dec 1971. 24p. Dep. NTIS.

In accordance with requirements, it was determined that the construction permit for the plant should not be suspended pending completion of the NEPA environmental review. The background, environmental impact during the review period, foreclosure of alternatives during the prospective review period, cost of delays, and balancing of factors are discussed. (M.C.G.)

6708 (NP-19017) FRONTAL ISOTOPIC CHROMATOGRAPHY: APPLICATION TO BORON. Chambu, C.; Blanc, C. (Societe Nationale des Petroles d'Aquitaine, Paris (France). Laboratoires Chimie Physique). Mar 1968. 77p. (In French). Dep. NTIS (U. S. Sales Only).

It is shown that frontal chromatography increases the element isotopic enrichment obtained by simple sorption during equilibrium. The expression of the amplification factor is given. The apparatus and measurement techniques used during the experimental study are described and the results are reported for boron isotopes. The model used for the theoretical calculations is compared with the experimental results. There is a quantitative agreement. (J.S.R.)

6709 (ORNL-TM-3140) ENGINEERING DEVELOPMENT STUDIES FOR MOLTEN-SALT BREEDER REACTOR PROCESSING NO. 5. McNeese, L. E. (Oak Ridge National Lab., Tenn.). Oct 1971. Contract W-7405-eng-26. 122p. Dep. NTIS.

Research progress is reported on: rare earth removal using the metal transfer process, protactinium isolation using fluorination and reductive extraction, axial dispersion in open bubble columns, semicontinuous reductive extraction experiments in a mild-steel facility, simulation of the flow control systems for the reductive extraction facility, calibration of an orifice-head pot flowmeter with molten salt and bismuth, electrolytic cell development with static cell experiments, formation of frozen films with aqueous electrolytes, development of a bismuth-molten salt interface detector, continuous salt purification, MSRE distillation experiment, recovery of ^{7}Li from ^{7}Li-Bi-rare earth solutions by distillation, prevention of axial dispersion in packed columns, and hydrodynamics of packed column operation with high-density fluids. (M.C.G.)

6710 (UJV-2475-Ch) SEPARATION OF RADIONUCLIDES OF Pr, La, Ba, Cs, Xe, AND Te FROM THE PRODUCTS OF SPALLATION OF CERIUM BY 680-MeV PROTONS. Mastalka, A. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Oct 1970. 13p. (In Czech). INIS.

A method was developed for the preparation and separation of radionuclides with neutron-deficient nuclei with atomic numbers between 52 and 59. The method is based on irradiation of Ce metal or a CeO_2 target and the separation of La, Ba, Cs, Xe, I, and Te from it for use in nuclear spectroscopy. The separation procedure consists of two steps; in the first step, separation into groups of elements is carried out within 15 to 20 minutes, in the second step, purification of individual elements follows. The basic operations are the dissolution of Ce or the CeO_2 target in concentrated HNO_3 + HF with separation of Xe, oxidation with $NaBrO_3$ (60°C), separation of I and Te on hydrated manganese dioxide, separation of Ce^{4+} with tributyl phosphate and its capture on ammonium phosphotungstate, decomposition of HNO_3 by a formaldehyde solution at elevated temperature, and capture of lanthanides and Ba on a Dowex 50 × 8 ion exchanger. Lanthanides are then eluted by 0.4 M ammonium α-hydroxyisobutyrate at pH = 4.7, and Ba by 5 to 6 M HCl. (INIS)

6711 (UJV-2643-Ch) SILICA GEL AS A SUPPORT FOR INORGANIC ION EXCHANGERS FOR SEPARATION OF ^{137}Cs FROM ACID SOLUTIONS. Caletka, R.; Konecny, C. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Jul 1971. 31p. Dep. NTIS (U. S. Sales Only).

A novel method of preparation and characteristics of inorganic ion exchangers based on ammonium molybdophosphate and insoluble hexacyanoferrates supported in silica gel, and their application to recovery of cesium from nitric acid solutions are described. (auth)

6712 (WaBoLu-3/70) CONTROL OF RADIOACTIVE WASTE WATER FROM NUCLEAR POWER PLANTS. Aurand, K.; Arndt, J.; Ruehle, H.; Wolter, R. (Bundesgesundheitsamt, Berlin (West Germany). Institut fuer Wasser-, Boden- und Lufthygiene). Aug 1970. 13p. (In German). INIS.

The control of contaminated waste waters as to the concentration and type of contained radionuclides was put in the foreground of the waste water problems from nuclear power plants in the FRG. First it was found out what radionuclides occur in the waste water of power reactors of different types and what radionuclides cause the main portion of radioactivity in a distinct waste water. For these radionuclides a search was done for possibilities of rapid analysis. Most of them can be determined by γ-spectroscopy, which requires chemical separation of the waste water depending on type of detector employed. For the pure β-emitters, τ, ^{89}Sr, and ^{90}Sr, a determination procedure was elaborated that gives results within 24 hr. Further investigations were made to what extent soluted radioactive rare gases can contaminate surface waters. (INIS)

6713 CHARACTERIZATION OF FORMS NOT EXTRACTABLE BY SOLVENT. Guillaumont, R.; Desire, B. (Univ. Paris, Orsay, France). Radiochem. Radioanal. Lett.; 8: No. 3, 183-7(10 Nov 1971). (In French).

Modification of Fomin's method is proposed to take into account adsorption of an element at tracer scale in checking inextractable species in solvent extraction and true D values. (auth)

6714 PRECIPITATION OF RUTHENIUM FROM IRRADIATED TBP/MEPASINE SOLUTIONS BY HYDROGEN SULFIDE. Nowak, M. (Inst. of Nuclear Research, Warsaw). Radiochem. Radioanal. Lett.; 8: No. 3, 165-73(10 Nov 1971).

Nitrato- and nitrato-nitro complexes of nitrosylruthenium (^{106}Ru-labeled) were precipitated from an organic phase with hydrogen sulfide. The solution of TBP in mepasine irradiated to a γ dose 160 Wh/l was used as the organic phase. By the addition of copper(II) nitrate as a scavenger, 99% of the ruthenium could be removed from the organic phase. (auth)

6715 FIRST HYDROLYSIS CONSTANT OF THE LANTHANIDES. Guillaumont, R.; Desire, B.; Galin, M. (Univ. Paris, Orsay, France). Radiochem. Radioanal. Lett.; 8: No. 3, 189-98(10 Nov 1971). (In French).

Formation constant β_1 of MOH^{2+}_{aq} ions from M^{3+}_{aq} was measured for all lanthanides (except cerium) by solvent extraction with TTA or DBM from perchlorate media. Variation of log β_1 versus z reflect large inexpected nephelauxetic effect of OH ligand through the 4f elements. (auth)

6716 CATION-EXCHANGE SEPARATION OF STRONTIUM FROM MANGANESE AND OTHER ELEMENTS IN CITRATE MEDIA. Strelow, F. W. E.: Boshoff, M. D. (National Chemical Research Lab., Pretoria). Talanta; 18: No. 9, 983-5(Sep 1971).

Mn(II) can be eluted quantitatively with 0.067M ammonium citrate at pH 7.0 or 7.5 from a column of AG50W-X8 cation exchange resin (200-400 mesh), and separated from Sr which is retained. Mg, Ca, Cu(II), Zn and Co(II) accompany Mn(II). From citric acid solutions up to 1M (20%) and from 5% citric acid solution at pH 2.2 both Mn(II) and Sr are retained very strongly. This is in agreement with some previous work but disagrees with a recent statement by others that 5% citric acid at pH 2.2 is an effective eluting agent for Sr. (auth)

6717 DECONTAMINATION OF RADIOACTIVE NITROSYL RUTHENIUM COMPLEXES BY ACTIVATED CARBON. **Matsumura, Takashi; Ishiyama, Toshio. Annu. Rep. Radiat. Center Osaka Prefect.; 11: 44-9(1970).**

The adsorption properties of activated carbon were studied for the purpose of removing nitrosyl ruthenium complexes from liquid wastes. First, (RuORu) nitrate, nitratonitrosyl, and nitronitrosylruthenium complexes labeled with ^{106}Ru – ^{106}Rh were synthesized by RuO_4 distillation or Fletcher's method. The test liquids were prepared by diluting these complexes with desalted water. To the test liquid, the powdered activated carbon was added and removal was measured. Removal of the complexes increased with the increase in stirring time. Each complex was entirely removed by the addition of activated carbon of 500 ~ 700 ppM. Nearly constant removals were obtained at a pH range between 4 and 9. Removal was not influenced by the presence of competing Na or K ions and decreased slightly by the presence of NO_2, NO_3, or Ca ions. Each complex was hardly removed by the conventional chemical treatment, such as ferric hydroxide or phosphate flocculation. Then, the test liquid of nitronitrosylruthenium was passed through the column packed with 200 ml of powdered activated carbon at a flow rate of about 10 ml per min. A decontamination factor higher than 10^2 was obtained even at a volume ratio of 2×10^3. Moreover, the test liquid containing fission products was used and activity measurements were made by γ spectrometry using a Ge(Li) detector. It was found that ^{131}I, ^{140}La, ^{144}Ce, ^{140}Nd were entirely removed and ^{103}Ru, ^{140}Ba, and ^{95}Zr were effectively removed. From the results obtained, it was found that activated carbon is an excellent adsorbent for removing nitrosylruthenium complexes from low-level waste water. (auth)

6718 EUREX PROGRAM. **Com. Naz. Energ. Nucl., Notiz.; 17: No. 7, 29-54(Jul 1971). (In Italian).**

Discussion is given on the history of the program and its intended purposes, the main characteristics of the physical plant, and initial operating experiences for the period ended in the spring of 1971. (auth)

6719 2-AMINOBENZOTHIAZOLE AS A SELECTIVE REAGENT FOR THE EXTRACTION OF MERCURY(II). **Tandon, S. N.; Srivastava, P. K.; Joshi, S. R. (Univ. of Roorkee, India). J. Radioanal. Chem.; 8: No. 1, 123-6(Jun 1971).**

In nuclear reaction studies, there is a good chance of gold radionuclides accompanying mercury activity due to side reactions. Therefore, the separation of Hg from Au was studied. It is shown that 2-aminobenzothiazole can be used for the selective extraction of mercury. (M.C.G.)

6720 INSTALLATION FOR RADIOACTIVE WASTE DISPOSAL. **Kajihara, Yoshinori (Hitachi Shipbuilding and Engineering Co. Ltd., Osaka). Sangyo Kikai; No. 243, 60-6(Dec 1970). (In Japanese).**

Disposal processes for radioactive wastes depend on characteristics of the wastes, species of radioactive materials present, and their radioactivity. There are three types of fundamental concepts of waste disposal. They are concentration-volume reduction, dilution-diffusion, and storage-decay. Evaporation and concentration equipment, freezing and remelting equipment, incinerators, and presses used in Japan are described. The evaporator in KUR (Research Reactor Institute, Kyoto University) has a mist separator consisting of a packed tower and a cyclone. The freezer-remelter gave good volume reduction of wastes. For the combustion process, a flowsheet for the incinerator in the Japan Atomic Energy Research Institute is shown. (Japan)

6721 ISOTOPE EFFECTS IN PALLADIUM–HYDROGEN SYSTEMS. THE CONCENTRATION OF DEUTERIUM AND TRITIUM. **Wicke, E. (Univ. of Muenster, Ger.). Platinum Metals Rev.; 15: No. 4, 144-6(Oct 1971).**

Palladium dissolves the isotopes of hydrogen in a selective manner and can be used, therefore, to facilitate separation and concentration processes. Although simple absorption techniques permit high separation factors under equilibrium conditions, no satisfactory counter-current process capable of separation by absorption has yet been developed. Better results are obtained by using the electrolytic diffusion technique, which allows kinetic separation factors to operate. (auth)

6722 CHEMICAL SEPARATION OF KURCHATOVIUM. **Zvara, I. (Joint Inst. for Nuclear Research, Dubna, USSR). Inorg. Nucl. Chem. Lett.; 7: No. 11, 1109-16(Nov 1971).**

Further studies are reported with the object of substantiating the claim by the Russians to have been the first to isolate and identify Element 104, which they named kurchatovium (Ku). This claim was disputed by the Berkeley Group, USA (A. Ghiorso and others), who named the element rutherfordium(Rf). (UK)

6723 COMMENTS ON CHEMICAL SEPARATION OF KURCHATOVIUM. **Ghiorso, A. (Univ. of California, Berkeley). Inorg. Nucl. Chem. Lett.; 7: No. 11, 1117-19(Nov 1971).**

Reference is made to the paper by Zvara and others (loc. cit. 7: 1109(1971)), in which their ephemeral Ku activity is interpreted in terms of an assumed spontaneous fission branching decay of ^{259}Ku and not ^{260}Ku. It is claimed that the former nuclide was previously discovered by the Berkeley Group, and that the new studies by the Russians do not support their claim to prior discovery of Element 104. The American name for this element is rutherfordium(Rf). (UK)

6724 FLUORIDE COMPLEXES OF TANTALUM(V). **Nabivanets, B. I.; Lukachina, V. V. (Inst. of General and Inorganic Chemistry, Kiev). Ukr. Khim. Zh.; 37: No. 6, 581-90(Jun 1971). (In Russian).**

The ionic state of tantalum(V) in acid fluoride solutions was studied by means of solubility, ion exchange, and extraction. The formation of the complexes $Ta(OH)_2F_3^0$, $Ta(OH)_4^-$, TaF_6^-, and TaF_7^{2-} was noted, and their equilibrium constants were determined. These constants were useful in calculating the conditions of anion exchange of Ta and its extraction by cyclohexane from acid fluoride solutions. (tr-auth)

6725 PROGRESS IN HEAP-LEACHING INVESTIGATIONS ON DIFFERENT TYPES OF URANIUM ORES. **Dar, K. K. (Dept. of Atomic Energy, New Delhi). Proc. Indian Nat. Sci. Acad., Part A; 36: No. 6, 360-71(Nov 1970). (CONF-681088-8).**

From Symposium on the geology and mineralogy of atomic mineral deposits and their development for use in the nuclear power program; New Delhi, India (14 Oct 1968).

On the assumption that uranium requirements in the 1981 to 2000 period will far exceed the existing reserves, and that future discoveries of high-grade surface and near-surface deposits are not likely to be as frequent as they were in the early days of uranium exploration, recourse to exploitation of small deposits of high-grade and large deposits of low-grade uranium would be inevitable. It is suggested that then heap-leaching of ores, the transportation costs of which would not be economic and for which the installation of conventional mills not warranted, will become necessary for uranium extraction. Work carried out on some domestic ores of various characteristics is reviewed. Attention is drawn to the savings in time achieved with equivalent recoveries in comparison with time that is normally considered necessary for heap-leaching. It is suggested that this method may also come to be employed for extraction of base metals from small and scattered domestic deposits, which may otherwise remain unexploitable. (auth)

6726 FLOTATION OF LOW GRADE URANIUM ORES WITH ISO-OCTYL PHOSPHATES. **Viswanathan, K. V.; Shukla, S. K.; Majumdar, K. K. (Bhabha Atomic Research Centre, Bombay). Proc. Indian Nat. Sci. Acad., Part A; 36: No. 6, 372-83(Nov 1970). (CONF-681088-9).**

From Symposium on the geology and mineralogy of atomic mineral deposits and their development for use in the nuclear power program; New Delhi, India (14 Oct 1968).

Low-grade uranium ores from Singhbhum Thrust Belt containing uraninite as the principal uranium-bearing mineral were earlier successfully beneficiated by flotation using isooctyl acid phosphate. The ore under investigation, also obtained from the same area, contained about 0.05% U_3O_8 as uraninite and 38% chlorite. About 16% of the total uranium values are intimately associated with the latter and another 16% are associated with other gangue minerals principally magnetite (8 to 9%). Isooctyl phosphate is not only a very good collector for uranium minerals but it also acts as a collector for chlorite and magnetite. However, by repeated cleaning operation of the flotation concentrate, these gangue minerals can be discarded but at the expense of uranium values. The following alkyl phosphates were prepared and used for flotation of low-grade uranium ores: (a) normal and isooctyl phosphates, (b) lauryl phosphates, (c) n-oleyl phosphates, (d) n-adol phosphates. Flotation of low grade uranium ores (0.02 to 0.05% U_3O_8 eq) with isooctyl acid phosphates and n-octyl acid phosphates at around a pH of 2.4 gave a concentrate assaying 0.14 to 0.168% U_3O_8, with a recovery of 80 to 85%. Under the same conditions $C_{12}-C_{18}$ alkyl phosphates gave higher grade concentrates (0.22 percent U_3O_8) but the recovery was only 70 to 75%. (auth)

6727 RESULTS OF SOME BENEFICIATION AND LIXIVIATION TESTS ON MEDIUM-GRADE URANIUM ORE IN QUARTZITE FROM CHHINJRA, KULU DISTRICT, HIMACHAL PRADESH. **Chatterji, B. D.; Deshpande, A. S.; Sharma, C. V.; Kulshrestha, S. C.; Sankran, R. N. (Dept. of Atomic Energy, New Delhi). Proc. Indian Nat. Sci. Acad., Part A; 36: No. 6, 384-91(Nov 1970). (CONF-681088-10).**

From Symposium on the geology and mineralogy of atomic mineral deposits and their development for use in the nuclear power program; New Delhi, India (14 Oct 1968).

Beneficiation tests on medium-grade uranium ore-analyzing 0.10% U_3O_8, from Chhinjra showed that, as compared to the low-grade ore (0.032% U_3O_8) from the area, uranium distribution in the sieved fractions is higher in the coarser sizes upwards +60 mesh (ASTM), and tabling yields a concentrate assaying 0.94% eU_3O_8 from a −100 mesh feed assaying 0.12% eU_3O_8 at a low recovery of barely 21%, and anionic flotation of deslimed feed at −200 mesh (ASTM) yields a concentrate analyzing 0.82% eU_3O_8 at 77.5% recovery. In order to reduce the cost of grinding to fine sizes and loss of uranium in physical beneficiation, agitation and percolation leaching tests were tried; the latter yielding better results than the former. Leachability increased from 36.0% without oxidant to 81.0% with the use of 10 lb/ton of MnO_2, the main function of the latter being to oxidize ferrous iron to ferric iron which, in turn, oxidized tetravalent uranium to the soluble hexavalent uranium. Removal of magnetics (0.10 wt %) from the sample decreased the leachability to 75% consequent on the decrease in the quantity of iron otherwise available for oxidation. (auth)

6728 SIMULATION OF THE SEPARATION PROCESS IN A PACKED COLUMN. Kaminskii, V. A.; Giorgadze, N. A. (State Committee on Utilization of Atomic Energy in Peaceful Goals, Moscow). Kernenergie; 14: No. 6, 194-7(Jun 1971). (In Russian).

A model of the packed column is proposed reflecting the statistical nature of packing. The hydrodynamic processes proceeding in the model are described mathematically. Equations are given for a sufficiently exact calculation of the hydraulic resistance of the packing, its holdup, and the flow rate in phase reversal point. The model can be used for estimating the height equivalent to a theoretical plate. (auth)

6729 MATHEMATICAL SIMULATION OF THE SEPARATION PROCESS OF STABLE ISOTOPES IN PACKED COLUMNS. Vereninov, I. A.; Muskhelishvili, G. N.; Puradashvili, D. K.; Rakitskii, Yu. V. (State Committee on Utilization of Atomic Energy in Peaceful Goals, Moscow). Kernenergie; 14: No. 6, 190-4(Jun 1971). (In Russian).

A process control system in the separation of stable isotopes should be based on the principle of automatic search for regimes of the separation units optimal with respect to given criteria. Specificity of processes in separation of stable isotopes in packed columns requires simulation in accelerated time scale. The model may be realized either as an individual element of control system (analog computer) or as a program assuming process control if put in a computer. The problem to realize a complete mathematical model of the process is considered. A method of asymptotic simulation is proposed, consisting virtually in the transition from the initial system of quasilinear differential equations, having small parameters in their derivatives of highest order, to a system of ordinary differential equations reflecting the features of the system to be transformed beyond some small ranges of argument. Beginning from a certain small value of argument t, the properties of transformed and initial systems coincide with sufficient accuracy. Using this technique, the general non-stationary problem of distribution of concentration along the column with respect to hydrodynamics can be solved. The method proposed, in which as the simulating unit both a digital or an analog computer may be used, was applied to solving the problem of separation of an isotopic mixture. The error of solution did not exceed 1 to 3 percent. The process characteristics calculated by means of the model were in good agreement with experimental data. (auth)

6730 TREATMENT OF LIQUID RADIOACTIVE WASTES. Sachse, G. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 14: No. 6, 177-81(Jun 1971). (In German).

Methods of purifying liquid radioactive wastes tested in practice or proving to be successful according to the recent state of testing are described. In addition to the methods used for a long time such as flocculation, precipitation, ion exchange, and evaporation, the methods of electrodialysis with use of ion-exchange membranes and contact softening are considered. Trends of development in improving existing techniques and applying new versions of existing techniques are discussed. (auth)

6731 SCANDIUM SORPTION FROM MIXTURES OF MINERAL AND ORGANIC ACIDS BY ION EXCHANGERS. Belyavskaya, T. A.; Brykina, G. D.; Isaeva, L. B. Vestn. Mosk. Univ., Ser. II. Khim.; 12: No. 4, 468-72(Jul-Aug 1971). (In Russian).

The sorption of scandium from mixtures of mineral acid (HCl), organic acid ($H_2C_2O_4$), and acetone by cation exchange and anion exchange was studied in a wide range of concentrations. In all the cases studied sorption from mixtures of hydrochloric and oxalic acids was lower than from mineral acid solution only. That is caused by scandium complexing with the organic acid ($H_2C_2O_4$). Organic acid and water distribution between the ion exchanger and the solution was also studied. (auth)

6732 DETERMINATION OF ISOTOPE SINGLE SEPARATION FACTOR BY THE METHOD OF RAYLEIGH DISTILLATION. Kuznetsova, E. M.; Salimova, K. M. Vestn. Mosk. Univ., Ser. II. Khim.; 12: No. 4, 484-6(Jul-Aug 1971). (In Russian).

Relations are given for calculation of the single separation factor by isotope composition changes of one of the components on exhaustive distillation with three or more isotope varieties present. The formulas were valid for equiprobable isotope distribution among isotope varieties. (auth)

6733 EXTRACTION-CHROMATOGRAPHIC SEPARATION OF NIOBIUM AND TITANIUM IN THE SYSTEM TRIOCTYLAMINE–HYDROCHLORIC ACID. Alimarin, I. P.; Gibalo, I. M.; Mymrik, N. A. Vestn. Mosk. Univ., Ser. II. Khim.; 12: No. 4, 457-60(Jul-Aug 1971). (In Russian).

The sorption of niobium and titanium was studied on a chromatographic column filled with teflon treated by trioctylamine, the height and the diameter of the column being 100 and 5 mm, respectively. Hydrochloric acid solutions were used as aqueous phase. The method was applied to the separation of titanium from niobium. The possibility of niobium concentrating on a chromatographic column was shown. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 6790, 6791, 6816, and 6817.

6734 (UCRL-72912) MARVEL: A NUCLEAR SHOCK TUBE. Crowley, Barbara K.; Glenn, H. David (California Univ., Livermore. Lawrence Radiation Lab.). 28 Dec 1970. 12p. (CONF-710719-1). Dep. NTIS.

From eighth international shock tube symposium; London, England (5 Jul 1971).

Marvel, a nuclear shock-tube experiment, consisted of a 2.2-kt nuclear explosive detonated 176 m underground at one end of a 122-m-long, 1-m-dia horizontal tunnel containing atmospheric air. The experimental and calculational results indicate the following: The high-energy air shock traveled down the tunnel nearly 50 times faster than the shock in the surrounding alluvium. Along the first 30 m of the tunnel, the shock had a velocity of about Mach 380. During its 4-msec transit of the entire 122-m tunnel, the shock attenuated to about Mach 30. Significant ablation of material from the tunnel walls was the primary method by which the air shock was attenuated. The energy from the nuclear explosive was preferentially channeled down the tunnel, resulting in a cone-shaped cavity. (auth)

6735 (UCRL-73258) REDUCTION OF TRITIUM FROM UNDERGROUND NUCLEAR EXPLOSIVES. Green, J. B. Jr.; Lessler, R. M. (California Univ., Livermore. Lawrence Livermore Lab.). 16 Sep 1971. 27p. (CONF-711009-9). Dep. NTIS.

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971).

The industrial application of the Plowshare concept of current interest is the stimulation of natural gas. The degree of success of this and other applications may be significantly affected by the amount of tritium produced by the nuclear explosion. The reduction of residual tritium has been the subject of continuing research and evaluation. Both public safety and economics are considered in planning this reduction. Tritium is produced from two major sources: the explosive itself, and the material and rock surrounding the explosive. The improved design of the low-residual-tritium Plowshare underground engineering explosive represents considerable progress in the reduction of the amount of tritium formed. Neutron shielding can reduce the amount of tritium formed external to the explosive. (auth)

Facilities and Equipment

Refer also to abstract 7718.

6736 (ALO-2683-1) DEVELOPMENT OF A 600° CENTIGRADE HEAT PIPE ASSEMBLY. Final Technical Report, January 3, 1966-January 3, 1967. (Radio Corp. of America, Lancaster, Pa.). 30 Apr 1969. Contract AT(29-2)-2683. 112p. (TL-317-82-994-99). Dep. NTIS.

The program for development of a 600°C automatic temperature-controlled heat pipe assembly was continued. Four heat pipes that were designed, fabricated, and tested were continued on life test for specific periods of time. Three of these heat pipes, Serial No. 3, 5 and 2, were removed from life test in operating condition after completing 6000, 6000, and 10,000 hours respectively. All three pipes were carefully packed and shipped to the Oak Ridge National Laboratories for detailed analysis. The results of the analysis showed a small area of erosion in the evaporator of each heat pipe. No other deleterious effects were observed. Heat Pipe, Serial No. 4, is continuing on life test and has accumulated over 20,000 hours of stable operation. (auth)

6737 APPARATUS FOR INSTALLING A REINFORCED VESSEL IN AN UNDERGROUND CAVITY. Wells, William M. (to United States Atomic Energy Commission). U. S. Patent 3,603,096. 7 Sep 1971. Filed 10 Dec 1969.

The equipment and method for installing a reinforced vessel in an underground cavity are described. A distensible vessel, reduced in diameter by means of folds in its sidewall, is passed through a bore into a cavity and is expanded to size by internal pressure. The interior of the vessel is then reinforced by building up a suitably thick deposit of material applied to the walls in an adherent spray by means of an arc-spray gun arranged to traverse the interior of the vessel. (Official Gazette)

6738 APPARATUS FOR MANIPULATING ARTICLES. (to International Business Machines Corp.). British Patent 1,246,280. 15 Sep 1971. Priority date 2 Jan 1968, United States.

The design and operation of an automatic robot, or hydraulically operated manipulator, for grasping, positioning, and joining parts is described. Movement of the multi-jointed manipulator arm is dictated by a perforated tape with coded instructions on the amount, sequence, and mode of displacement. The main components of the manipulator are: a tape reader; electric and hydraulic control mechanisms; a cable-driven device for producing the required sliding, gripping, and rotating motion at the output end of the manipulator arm; and a vibrating hydraulic search mechanism. (L.C.L.)

6739 PUMPS AND BLOWERS FOR CIRCULATING COOLANTS IN NUCLEAR REACTORS. Matsui, Hiroo (Ebara Mfg. Co. Ltd., Tokyo). Sangyo Kikai; No. 243, 48-53(Dec 1970). (In Japanese).

Coolant circulating pumps used for BWR, PWR, and GCR-type nuclear power plants are discussed. The number of recirculating pumps in nuclear power plants depends on their output. One circulating pump per 100 to 125 MW output has already been supplied, while it is planned to increase circulating quantity with jet pumps which are arranged around cores and actuated by discharge pressure of the recirculating pumps. This method makes it possible to increase the recirculating quantity without increasing number of circulating loops. Although it requires recirculating pumps with higher lift and larger power, it results in lower costs and improved safety. PWR power plants require primary coolant circulating pumps, which are usually vertical single-stage pumps, at the rate of one loop per about 250 MW output, instead of the recirculating pumps in BWRs. In case of GCR plants with recent improvements, the following systems are being adopted: CO_2 is circulated in pressure vessels made of prestressed concrete, in which reactor cores, steam generators, etc. are contained without circulating pipes. The type of blowers used is usually a single stage centrifugal or axial flow type. (Japan)

6740 CLOSURE MEMBER AND ASSEMBLY. (to Brown Boveri/Krupp Reaktorbau GmbH). British Patent 1,242,036. 11 Aug 1971. Priority date 29 Jan 1969, Germany.

A closure member capable of operating at high temperatures in radiation fields is described. The closure member is suitable for use in shutoff and regulating valves for fluids in nuclear energy installations. The sealing member is removable and is made of polyimide. The closure member is preferably stainless steel. (J.R.D.)

6741 IMPROVEMENTS IN OR RELATING TO A METHOD OF, AND AN APPARATUS FOR, AUTOMATICALLY AND PERIODICALLY DETERMINING THE RATE OF SETTLING OF SUSPENDED MATTER IN A LIQUID. (to Commissariat a l'Energie Atomique). British Patent 1,244,199. 25 Aug 1971. Priority date 24 Oct 1967, France.

A method and apparatus for automatically determining the settling rate for particles suspended in a liquid are described. The suspension is sampled using a glass measurement cell in which the suspension is agitated after which the settling time is measured. The settling time is determined by use of a sensor usually comprising a light projector to send a beam of light through the cell to a photoelectric detector. (J.R.D.)

6742 ENCAPSULATING METHOD. Scarborough, Donald D. (to United States Atomic Energy Commission). U. S. Patent 3,608,023. 21 Sep 1971. Filed 4 Sep 1969.

A method is described for encapsulating components utilizing individually evacuatable molds for receiving the components which may be separated and removed from the means evacuating the mold without loss of vacuum and positioned within an evacuated chamber where the molds may be opened and the component encapsulated under vacuum. The mold with encapsulated component may thereafter be subjected to atmospheric pressure and the encapsulant cured. (Official Gazette)

6743 NUCLEAR POWER PLANT WITH COMBINED GAS AND STEAM TURBINES. Frutschi, H. (to Escher Wyss Ltd.). Canadian Patent 873,085. 15 Jun 1971. Priority date 6 Mar 1968, Switzerland.

The working fluid (gas) absorbs heat from the nuclear reactor. Heat not utilized in the gas turbine plant is transferred by heat exchanger to the steam in steam turbine plant. The quantity of gas used for preheating the steam is smaller than the quantity used for evaporating and superheating the steam. There are two compressors in the gas turbine plant, one for the first quantity of gas and the other for the second quantity of gas. (F.S.A.) (Canada)

6744 IMPROVEMENTS IN AND RELATING TO ROTARY IMPELLER PUMPS. (to Babcock and Wilcox Co.). British

Patent 1,242,119. 11 Aug 1971. Priority date 15 Sep 1967, United States.

The pump is designed for use in nuclear steam generators which utilize a plurality of coolant pumps in parallel having common coolant inlet and outlet headers. Provision is made to close the passageway occupied by the impeller if the pump fails so that other pumps may continue to circulate coolant from the common inlet header to the common outlet header thus maintaining flow. (J.R.D.)

Heat Transfer and Fluid Flow

Refer also to abstracts 6743, 7184, and 8557–8559.

6745 (IEA–196) FINAL STUDY OF A GAMMA SHIELD. Picciotti, Guido; Filho, Joaquim de Sylos Cintra; Nigro, Francisco Emilio Baccaro; Gannam, Waldir Delano Abu (Instituto de Energia Atomica, Sao Paulo (Brazil)). Dec 1969. 58p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

The results obtained for the temperature distribution in a shielding plate with flat geometry, composed of two materials, heated by gamma-rays and cooled by water in the forced convection regime are presented. Two methods were used to determine analytically the field of temperatures in the plate. In the first method the temperature distribution was assumed to be one-dimensional in each section of the plate. This was equivalent to supposing that the plate was composed of superpositioned elements adiabatically separated from each other. In the second method the temperature was assumed to be function of two coordinates what constituted a more realistic assumption. The integration of the two-dimensional heat conduction equation was carried out by a numerical procedure. Finally, comparison of the results obtained by these two methods made possible an evaluation of the advantages and disadvantages of each method. (auth)

6746 (LA–4754) SOME PRELIMINARY NUMERICAL STUDIES OF TAYLOR INSTABILITY WHICH INCLUDE EFFECTS OF MATERIAL STRENGTH. Meyer, K. A.; Blewett, P. J. (Los Alamos Scientific Lab., N. Mex.). Aug 1971. Contract W-7405-eng-36. 9p. Dep. NTIS.

In this numerical study a two-dimensional Lagrangian code, TOODY II, is used to compute the growth of a perturbed interface between a perfect gas and an aluminum plate. The interface undergoes acceleration in the direction of the gas to the aluminum. Using an elastic perfectly plastic model for the aluminum the effects of yield strength, density ratio, wavelength, initial amplitude, and the elastic shear modulus on the perturbation growth rate are presented. Results are compared with Taylor theory and an attempt is made to develop an analytic expression for the effect of yield strength. (auth)

6747 (NP–19112) PRESSURE LOSS AND HEAT TRANSFER ON SMOOTH AND ROUGH SURFACES AT HIGH TEMPERATURES AND TURBULENT FLOW AND THEIR REPRESENTATION BY UNIVERSAL LAWS. Meerwald, E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). May 1971. 98p. (In German). Dep. NTIS (U. S. Sales Only).

In fast reactor cores very high power densities are present. It is therefore necessary to improve the heat transfer from the fuel elements to the coolant. The experiments were performed with 15 different electrically heated rough rods at surface temperatures up to 1200°C, contained in concentric smooth tubes. Heat transfer and friction correlations were developed for turbulent flow in annulus having a repeated-rib roughness. The friction correlation is based on law of the wall similarity. The heat transfer correlation is based on application of a heat-momentum transfer analogy to flow over a rough surface, which was first used by Dipprey and Sabersky for sand-grain roughness. The friction correlating parameter and the heat-momentum analogy correlation is compared with other roughnesses found in the literature. (auth)

6748 (STU–68–263/U–210) STUDIES OF TURBULENT FLOW PARALLEL TO A ROD BUNDLE OF TRIANGULAR ARRAY. Kjellstroem, B. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Mar 1971. 164p. Dep. NTIS (U. S. Sales Only).

Results are presented from an experimental and theoretical study of turbulent flow in a rod bundle of triangular array with pitch to diameter ratio of 1.217. The experiments included measurements of pressure drop and local distributions of axial and secondary flow velocities, turbulence intensities, Reynolds stresses and the wall shear stress. The results of the turbulence measurements were used for calculation of local eddy diffusivities. It is shown that the diffusivity is strongly nonisotropic—the diffusivity in peripheral direction being a factor from 5 to 1.5 higher than that in radial direction, the higher value valid for the wall region, the lower for the core of the flow. The theoretical studies included calculations of the distributions of the axial velocity and the kinetic energy of turbulence in the flow, using the computer program developed by Spalding (1968). A modified version of Prandtls energy-length model (1945) in combination with Buleevs method (1963) for estimation of the turbulent length scale was employed. The calculated results are compared to the measured data and it is concluded that the agreement is satisfactory except close to the wall and in the region of maximum velocity for $\varphi = 30^\circ$. Better agreement would probably have been obtained if a finer grid subdivision had been used. For economic reasons it is recommended that some changes in the program are made before calculations with a finer grid are carried out. (auth) (Sweden)

6749 HEAT EXCHANGER. Junkermann, Wolfgang (to Deutsche Babcock and Wilcox AG). German Patent 1,501,493. 14 Aug 1969. Filed 22 Jul 1965. (In German).

A heat exchanger placed in the annulus of an integrated reactor is described. The plane heat exchanger elements parallel to each other are arranged tangentially. The length of the elements increases in correspondence to their distance from the system midpoint. (tr-auth)

6750 MASS TRANSFER AND PRESSURE LOSSES IN PARALLEL FLOW THROUGH ROD CLUSTERS WITHIN A WIDE RANGE OF REYNOLDS NUMBERS AND PITCHES. Presser, K. H. (Institut fuer Reaktorbauelemente, Juelich, Ger.). Int. J. Heat Mass Transfer; 14: No. 9, 1235-59(Sep 1971). (In German).

An investigation is reported for smooth rod clusters in flow parallel to the axis in an almost infinite triangular lattice. The ratios of center-to-center spacing (pitch) to rod dia were 1, 1.02, 1.05, 1.2, and 1.67. For isothermal conditions and constant partial pressure on the wall, the mass transfer by sublimation of naphthalene, camphor, paradichlorbenzene and thymol in air flow, and friction factors were measured. Measurements were in the ranges $200 < Re < 200{,}000$ and $2.2 < Sc < 2.6$. The influence of the ratios of pitch to rod dia and the Reynolds-number on the friction coefficient, the average Sherwood-number and the distribution of the local Sherwood-number around the rod circumference were specified. The course of the local Sherwood-number in the mass transfer entrance region with fully developed velocity profile was investigated. A comparison was made both between the theories of Deissler/Taylor for turbulent flow and Sparrow-Loeffler for laminar flow and with other experimental results. Results were as follows: friction coefficient in turbulent flow could be presented in form of the Prandtl–Kármán relation and in laminar flow as the Hagen–Poiseuille relation, empirical coefficients depending on ratio of pitch to rod dia; the critical Reynolds-number was lower than in tube flow; the analogy based on the Prandtl–Kármán theory between mass and momentum transfer in turbulent and laminar flow was valid for ratios of pitch to rod dia; for certain ratios of pitch to rod dia variation of Sherwood-number and of friction coefficient was observed; in turbulent flow the hydraulic entrance length amounted to 20 equivalent dia: the mass-transfer entrance length with fully developed velocity-profiles required a dimensionless distance in stream direction of about 5000. (UK)

Isotope Technology

Refer also to abstracts 6736, 6771, and 6830.

6751 (MLM–1828) STABLE GASEOUS ISOTOPE SEPARATION AND PURIFICATION: APRIL–JUNE 1971. (Mound Lab., Miamisburg, Ohio). 7 Oct 1971. Contract AT-33-1-GEN-53. 44p. Dep. NTIS.

Results of research on carbon isotope separation are presented. Separation methods such as CO distillation, chemical exchange, liquid thermal diffusion, and gaseous thermal diffusion were studied. Efforts devoted to stable gaseous isotope separation are summarized. Work on separation of isotopes of Ar, He, Ne, Kr, and Xe is reported. Thermal diffusion research is reported on molecular beam scattering, transport properties, isotopic thermal diffusion factors for Kr, and mutual diffusion coefficients. Low temperature research is reported on ^{3}He distillation, superfluid film phase transition in He mixtures, and vapor pressure ratio in mixed ^{20}Ne and ^{22}Ne. (J.R.D.)

6752 (MLM–1861) STABLE GASEOUS ISOTOPE SEPARATION AND PURIFICATION: JULY–SEPTEMBER 1971. (Mound Lab., Miamisburg, Ohio). 15 Oct 1971. Contract AT-33-1-GEN-53. 24p. Dep. NTIS.

Results of research are presented on carbon isotope separation by CO distillation, chemical exchange, liquid thermal diffusion, gaseous thermal diffusion, and carbonate conversion. Work on separation of gaseous isotopes of Ar, He, Kr, Ne, and Xe is summarized. Other work is reported on diffusion in H–He and H–^{4}He systems. Research on low-temperature ^{3}He distillation is also reported. (J.R.D.)

6753 (N–71–34621) SIMULATED ISOTOPE HEAT SOURCE FOR USE IN BRAYTON POWER SYSTEM. Smith, Robert B.; Prok, George M. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Sep 1971. 12p. (NASA-TM-X-2374). NTIS.

A simulated isotope heat source was designed and tested for use in the Brayton power system. The simulated isotope heat source enables ground testing of flight-like hardware without the inherent hazards of the isotope heat source. The simulated isotope heat source is electrically powered, and was operated for 820 hours at various power levels. The design objectives for the simulated isotope heat source were met. Power and temperature levels were well within a usable range and the life was demonstrated to be sufficient for preliminary testing of the isotope Brayton cycle. An array of electrically heated simulated isotope heat sources may be used to supply 25 kilowatts or more of thermal power to the Brayton system heat source heat exchanger. (auth) (STAR)

6754 (ORNL–TM–2959) REFERENCE DESIGN FOR A THERMOELECTRIC ISOTOPE POWER UNIT EMPLOYING HEAT PIPE MODULES. Fraas, A. P.; LaVerne, M. E. (Oak Ridge National Lab., Tenn.). Nov 1971. Contract W-7405-eng-26. 58p. Dep. NTIS.

A reference design for a 2 kW(e) thermoelectric power unit has been evolved to serve as the basis for technology evaluation tests in Task II of the Isotope Kilowatt Program. This reference design makes use of potassium heat pipes to transport heat to thermoelectric modules from the same basic heat block-shield assembly as would be used for the organic and steam Rankine cycle systems of this program. The heat block-shield employs seven capsules of ^{90}Sr in the form of $SrTiO_3$ encased in Hastelloy. Designs for both iron and nickel heat block-shield units have been prepared. Twelve thermoelectric modules; each with a 1-in. diameter, 79-in. long heat pipe, are designed to produce 167 W each at 24 V. They can be coupled in a series-parallel arrangement to yield 2 kW(e) at 48 V. The design is based on lead telluride thermoelectric junctions, but is equally well suited to use with advanced materials yielding a higher efficiency when these become available. The design studies have been extended to include an investigation of the improvement in performance that might be obtained with the new TPM-217 thermoelectric material under development at the 3M Company. Studies at 3M under an ORNL subcontract show promise of increasing the overall thermal efficiency from the 8.5% estimated for the present lead telluride material to 11.1% for the TPM-217 material. This improvement would entail increasing the hot junction temperature from 1050 to 1350°F, and would require the use of nickel in place of iron for the heat block-shield assembly. (auth)

6755 (ORNL–TM–2961) REFERENCE DESIGN OF A 3 kW(e) STEAM RANKINE CYCLE SYSTEM FOR AN ISOTOPE POWER PLANT. Fraas, A. P. (Oak Ridge National Lab., Tenn.). Nov 1971. Contract W-7405-eng-26. 34p. Dep. NTIS.

A reference design for a 3 kW(e) steam Rankine cycle system has been evolved for undersea applications. The system makes use of a heat block-shield assembly designed so that it is suitable for use with an organic Rankine cycle system or a thermoelectric system as well as the subject steam system. The turbine-generator used in the system is one developed by Swenson Research Laboratories, Inc. Unfortunately, only the initial development phase of this effort has been completed and funding is not available for further work. No other unit well suited to this application has been found. The principal uncertainties and development problems associated with the proposed reference design are associated with the turbine-generator-pump unit. These include the problem of obtaining high reliability in the bearings, freedom from deterioration of the generator windings as a consequence of moisture permeation into the electrical insulation, and possible corrosion of the magnetic material exposed to steam in the generator. These problems appear tractable, but there is no funded effort directed toward their solution at the time of writing. (auth)

6756 (WANL–4219-1) FPMS LIFE TEST. Annual Report. Van Bibber, L. E. (Westinghouse Electric Corp., [Pittsburgh], Pa. Astronuclear Lab.). Jul 1971. Contract AT(30-1)-4219. 30p. Dep. NTIS.

The SNAP-23A Fueled Prototype Mockup System has been on system thermal and life test since February 1970. It has accumulated 11,560 hrs of testing through June 30, 1971 of which 9930 have been accumulated on life test with the Prototype Mockup Converter PMC-3. On June 30 the system was producing 66 watts at an overall efficiency of 6.2%. The fuel power level was 1053 W corresponding to 4.7 yrs from the nominal fuel design loading of 1180 W. During the life test period the system has performed as predicted without any apparent degradation of system components and interfaces. The only change in performance has been that due to fuel decay. (auth)

6757 SEPARATION OF URANIUM ISOTOPES BY THE DIFFUSION, GAS CENTRIFUGE, AND SEPARATION NOZZLE METHOD AND THEIR ECONOMIC SIGNIFICANCE. Bulang, Wolfgang (Dornier AG, Friedrichschafen, Ger.). Chem. Ztg.; 95: No. 6, 252-61(Mar 1971). (In German).

The demand for energy in the world is doubling every ten years. There will be an increasing part of this generating capacity supplied by nuclear energy. By 1980 about 80 percent of total generating capacity is predicted to be in light water reactors. The cumulative US production of enriched uranium will cover the estimated world demand until 1977. From that time on there must be additional enrichment capacity installed. In Europe three separation methods are anticipated: The gaseous diffusion, the centrifuge and the separation nozzle. The theory of isotope separation is treated. The three methods are discussed. Centrifuge is far less developed than diffusion but seems interesting from the economic point of view because of the greater flexibility in meeting the increasing demand by installation of new separation capacity and because of far lower specific energy consumption. (auth)

6758 ECONOMIC PROBLEMS OF ISOTOPIC POWER GENERATORS. Ishimatsu, K. (Hitachi Ltd., Tokyo). Genshiryoku Kogyo; 17: No. 7, 26-31(Jul 1971). (In Japanese).

A review of the production of radioactive wastes in Japan, mixed fission products (MFP), choice of radioisotopes, thermoelectric conversion systems, and application of isotope generators is presented. Methods for concentrating radioactive wastes for use in producing useful radioactivity are described. Isotopic generators are advantageous for use at isolated places for sonar beacons, automatic weather stations, communication systems such as submarine telegraphy, and pacemakers for hearts. It is reported that ^{238}Pu will be produced by the French Atomic Energy Agency in 1973 in amount necessary for 2,000 hearts, and by 1974 for 10,000 hearts. In Japan, electric power supply by atomic energy which is just beginning, will exceed 20 kMW in 1980, and exceed 80 kMW in 1990. ^{144}Ce is the fission product which will be obtained in the largest amounts at that time. (Japan)

6759 USE OF RADIOACTIVE ^{54}Mn IN SHORT-DISTANCE GAMMA RADIOGRAPHY. Averin, Yu. P.; Vasil'ev, L. S.; Danilin, L. D.; (and others). Sov. J. Nondestruc. Test. (Engl. Transl.); No. 4, 371-2(Jul-Aug 1969).

Translated from Defektoskopiya; No. 4, 8-10(Jul-Aug 1969).

The use of ^{54}Mn in gamma radiography was evaluated using a Lucite capillary filled over a length of 1 mm with Dowex 50 × 12 resin in the H form. A purified solution of ^{54}Mn was passed through the capillary. The resin capacity was found to be 250 mCi. Tests using this loaded resin for radiographic examination of metals are described. (J.R.D.)

6760 ABSOLUTE DETERMINATION OF THE ACTIVITY OF EXTENDED GOLD SOURCES. Dobrescu, S.; Mihai, Ioana; Petrascu, M.; Savu, V. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 4, 435-47(1971).

Using a $4\pi\ \beta-\gamma$ method the best conditions for a gold source of 40 mm diameter were obtained with an accuracy better than 1%. The method involves choosing the most suited values for the discrimination threshold of the beta channel and the resolving time of the coincidence unit. An alternative possibility is to use a specially-shaped iron piece in order to make the gamma detection efficiency independent of the emission point for large diameter foils. The maximum diameter of gold sources used was 40 mm, but it seems probable that even larger sources may be measured by an adequate design of the counting system. Absolute activity measurements of other radiation sources of large areas may be also performed but they require a readjustment of the working parameters in every case because they depend on the emitted radiation energies. (auth)

Materials Testing

Refer also to abstracts 6445, 6759, 6773, 6825, 6836, and 7200.

6761 (INIS-mf–56) NONDESTRUCTIVE TESTING OF FUEL ROD SHEATHS. Abrales, H.; Barman, I. L.; Venturino, C. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1970. 8p. (In Spanish). (CONF-701124–2). INIS.

From Metallurgical meeting; Cordoba, Argentina (Nov 1970).

Fuel rod claddings (thin-walled Zircaloy tubes) require very rigid defect and dimensional control. Some methods used in the CNEA to measure the exterior diameter, interior diameter, defects and roughness are described. To measure the exterior and interior dimensions an electromagnetic system based on the variation of the reluctance of a coil was used. The defects were evaluated with an eddy current system. The roughness was measured by a commercial Hommel Werke device. The methods and the results obtained are discussed. (tr-auth)

6762 (UCRL-73272) ROUND-ROBIN TESTING OF ACOUSTIC EMISSION SOURCE. Brown, A. E.; Liptai, R. G. (California Univ., Livermore. Lawrence Radiation Lab.). 29 Jun 1970. 29p. (CONF-711201-1). Dep. NTIS.

From Conference on acoustic emission; Bal Harbour, Fla. (7 Dec 1971).

The use of a martensitic phase transformation in Au-47.5 at. % Cd alloy as a source of acoustic emissions is discussed. The use of this source as a "standard" provided a means of comparing acoustic emission data from several laboratories. However, repeated cycling apparently changed and degraded the alloy, making it inappropriate as a standard source for acoustic emissions. The results of round-robin testing of this alloy at various laboratories are presented. (auth)

6763 NDT HOLOGRAPHIC TECHNIQUES TO DETERMINE THE SWAGE JOINT TIGHTNESS OF THE ATR FUEL ELEMENTS. Arave, A. E.; Stanley, M. L. (Aerojet Nuclear Co., Idaho Falls, Idaho). Mater. Eval.; 29: No. 11, 259-64(Nov 1971).

Several NDT techniques were investigated to determine the swage joint tightness of the Advanced Test Reactor (ATR) fuel element. The most promising and efficient is the holographic interference pattern technique, referred to as a strain pattern technique. The fuel plates are stressed in such a manner that a strain pattern, indicative of swage joint tightness, is generated on the side plate of the fuel element. By analytical studies and relative comparison with other fuel elements the technique can be developed into a reliable nondestructive test. Strain patterns observed by holography are illustrated. Variables that must be held constant to obtain valid holographic strain patterns are discussed with illustrations of the effect they have on the information. (auth)

6764 USE OF GAMMAGRAPHIC METHODS FOR THE EXAMINATION OF CONCRETE STRUCTURES. Eering, J. Th. (Roentgen Technische Dienst NV, Rotterdam). Ingenieur (Utrecht); 6: 1-6(12 Feb 1971). (In Dutch).

The principle of the gammagraphic method is explained; the choice of the many parameters for this examination is elucidated from the practical point of view. The equipment is briefly described, and examples of applications are given. The influence of required radiation safety precautions is pointed out. Some attention is given to the interpretation of the results of the examination. (auth) (Netherlands)

6765 IMPACT TESTING OF METALS. Symposium Presented at the Seventy-Second Annual Meeting, Atlantic City, N. J., 22-27 June 1969. ASTM Special Technical Publication 466. Philadelphia; American Society for Testing and Materials (1970). 320p. $21.25. (ASTM-STP-466; CONF-690664).

Fifteen papers were presented at the conference. Papers are included on applicable equipment, the effects of variables, and correlations for tear tests. Separate abstracts were prepared for two of the papers considered in the scope of NSA. (J.R.D.)

For abstracts of individual papers see: 6766 and 7172.

6766 APPLICATIONS OF THE INSTRUMENTED CHARPY IMPACT TEST. Wullaert, R. A. (Battelle Memorial Inst., Columbus, Ohio). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 466, 148-64(970).

From Symposium on impact testing of metals; Atlantic City, N. J. (22 Jun 1969).

Studies involving the application of the instrumented Charpy impact test are presented. The studies were concerned with the effect of strain rate, alloying, and irradiation on the ductile-brittle transition temperature (DBTT) and fracture behavior of pressure vessel steels. The effect of strain rate on a 0.02C and 0.02C-3.5Ni steel was evaluated by comparing instrumented Charpy tests with three-point slow bend tests on Charpy V-notch specimens. Increasing the strain rate (1) increased the DBTT, (2) increased the yield stress, and (3) decreased the temperature dependence of the yield stress. The strain rate sensitivity of the yield stress was mainly responsible for the increase in the DBTT. The instrumented Charpy test was used to determine why small nickel additions to steel are so effective in lowering the ductile-brittle transition temperature. The decrease in the DBTT was shown to be related to the decrease in the strain rate and temperature dependence of the yield stress produced by nickel. The effect of irradiation on A212-B steel was evaluated by use of the instrumented Charpy impact test. Irradiating A212-B steel at approximately 260°C to a fluence of 9.4×10^{18} n/cm^2 (>1 MeV) increased the DBTT 56°C. Irradiation increased the dynamic yield stress 30% but reduced the strain rate sensitivity of the yield stress. The increase in the ductile-brittle transition temperature was shown to be almost entirely due to the radiation-induced increase in the dynamic yield stress. (auth)

6767 LUMINESCENT METHOD OF INSPECTING THE AIRTIGHTNESS OF SCINTILLATION DETECTOR PACKING. Nikulina, R. A.; Malkes, L. Ya.; Vlasov, Yu. A.; Govorova, R. A. (All-Union Scientific Research Inst. of Monocrystals, Moscow). Sov. J. Nondestruc. Test. (Engl. Transl.); No. 1, 98-9(Jan-Feb 1969).

Translated from Defektoskopiya; No. 1, 116-17(Jan-Feb 1969).

A rapid method for inspecting the airtightness of scintillation crystal packing and containers is described. A luminescent liquid is used to fill the test container which is placed on white paper. After a period of 10 min, the paper on which the container had been placed and the container's outside surface are observed under ultraviolet light. If the container is not airtight, bright luminescence of the liquid that has passed through the micropores will be observed on the container surface or on the paper if the defects are in the container bottom. For better visibility of defects, the outside surface of the container can be dusted with magnesium oxide powder. (J.R.D.)

6768 HYGIENIC EVALUATION OF RADIATION FACTORS DURING GAMMA DEFECTOSCOPY. Sokolina, L. L. (Inst. of Industrial Hygiene and Occupational Sicknesses, Moscow). Sov. J. Nondestruc. Test. (Engl. Transl.); No. 1, 111-12(Jan-Feb 1979).

Translated from Defektoskopiya; No. 1, 127-8(Jan-Feb 1969).

Safety factors involved in operation of remote and portable radiation sources for materials testing are discussed. It is noted that important prophylactic measures include an efficient system for monitoring radiography personnel and maintaining hygienic and sanitary working conditions. (J.R.D.)

6769 RADIOGRAPHIC TESTING OF PIPE WELDS. Maruyama, Yutaka (Nippon Kokan K. K., Kawasaki, Japan). Keikinzoku Yosetsu; No. 99, 130-7(Mar 1971). (In Japanese).

There are three radiographic methods for testing pipes: single wall-single image; double wall-single image; and double wall-double image. Geometric conditions in radiography require that the distance between films and test samples be as short as possible, while the distance between radiation sources and penetrometers should be as long as possible. If x-ray equipment is used, it is better to arrange the x-ray tube axis parallel to pipe axis. The penetrometers are usually placed on the source-side surface of the samples, but sometimes are placed on film-side surface of the samples because it is often difficult to follow this rule in actual pipe testing. Principal standards for pipe welding other than general test methods for welds, i.e., JIS Z 3104 and Z 3105, are described and include: standard for laying high pressure gas pipelines (KHK S 0301); welding of gas pipelines (The Ministry of International Trade and Industry); American Petroleum Institute Standard; British Standard 2910; and Recommendation by International Institute of Welding. (Japan)

6770 EQUIPMENT FOR RADIOGRAPHY OF PIPELINES AND CLOSED VESSELS. Stein, Stephen (to National Research Development Corp.). British Patent 1,248,397. 29 Sep 1971. Filed 27 Dec 1967.

The design of a self-propelled, remotely controlled carrier for precisely positioning a radiation source inside a pipeline is described. This equipment may be used in the radiographic inspection of pipelines and pipeline welds. (L.C.L.)

6771 ^{60}Co GAMMA-RAY RADIOGRAPHY ON THICK STEEL AND CHARACTERISTICS OF LEAD FOIL SCREENS. Tsujii, Yukio; Furuta, Junichiro; Hiraoka, Eiichi. Annu. Rep. Radiat. Center Osaka Prefect.; 11: 115-17(1970).

The best conditions for defect sensitivity of thick steel samples are reported in the case of radiography using a ^{60}Co source. The measurements were made using a lead shield block, lead foils of several thicknesses, and penetrameters of the wire and Bacillus type. The defect sensitivities in these measurements were less than 1% at the 25 cm of steel thickness. (auth)

6772 DETECTION PROCESS IN NEUTRON RADIOGRAPHY. Garside, B. K.; Harms, A. A. (McMaster Univ., Hamilton, Ont.). J. Appl. Phys.; 42: No. 12, 5161-7(Nov 1971).

A model of the imaging process in the direct conversion for obtaining neutron radiographs is presented. The analysis is aimed at obtaining expressions for the attainable object resolution as a function of system and object parameters. Initially, the analysis is carried out assuming a parallel incident beam of neutrons in order to compute the best possible resolution. The results obtained are subsequently used to elucidate the effect of varying certain detection system parameters on both the resolution function and the relative exposure times for a gadolinium converter. Since the neutron beams used in radiography cannot generally be considered to be sufficiently close to parallel, the model has been extended to allow the incorporation of the effects of neutron beam divergence due to finite source size. Comparisons are presented between the results obtained from this model of the neutron radiographic process and experimental data already reported in the literature. (auth)

Radioactive Material Handling

Refer also to abstracts 6718, 6740, and 8592.

6773 (ANL–7839) NONDESTRUCTIVE ASSAY OF EBR-II FUEL PINS. Brandenburg, R. W. (Argonne National Lab., Ill.). Sep 1971. Contract W-31-109-eng-38. 10p. Dep. NTIS.

The expanding safeguards program and the increasing use of reactors as a source of power point up the desirability of having a program to assay large quantities of reactor fuel. The use of γ-ray assay as an effective means of verifying ^{235}U content for accountability purposes is discussed. There were 3423 fuel pins assayed; the difference between the fuel content as determined by γ assay and that reported by the vendor was less than 1% at the 95% confidence level. (auth)

6774 (ARH–1602) DESIGN CRITERIA PLUTONIUM–URANIUM PARTITIONING IN THE PLUTONIUM RECLAMATION FACILITY: 236-Z BUILDING. Muller, M. E. (Atlantic Richfield Hanford Co., Richland, Wash.). 23 Mar 1970. 16p. Dep. NTIS.

Design criteria for additions to the Plutonium Reclamation Facility to house equipment capable of processing 30 kg/day of Pu–U materials are summarized. The additions and modifications are listed and described. (J.R.D.)

6775 (CONF-711113–2) RADIOACTIVE WASTE MANAGEMENT IN RELATION TO THE ENVIRONMENT. Slansky, Cyril M. (Allied Chemical Corp., Idaho Falls, Idaho). 10 Sep 1971. 15p. Dep. NTIS.

From Regional training course in radioactive waste management conference; Tokyo, Japan (4 Nov 1971).

The effects on the environment of radioactive wastes which are produced by nuclear power generation and which are released to the environment are discussed. This type of waste accounts for 99% of all radioactive waste released to the environment and includes generally low-level gaseous, liquid, and solid wastes from operating reactors and fuel reprocessing plants. Separate brief discussions of the effects on the atmospheric, marine, and fresh water environments and on soils are presented. (L.C.L.)

6776 (CONF-711113–3) MONITORING AND PRETREATMENT ANALYSIS: RADIOACTIVE WASTE MANAGEMENT. Slansky, Cyril M. (Allied Chemical Corp., Idaho Falls, Idaho). 1 Oct 1971. 13p. Dep. NTIS.

From Regional training course in radioactive waste management conference; Tokyo, Japan (4 Nov 1971).

The monitoring of radioactive wastes released to the environment is discussed in terms of purpose, overall programs, sampling methods, and the analysis of samples. Methods for determining the radioisotope content in the atmosphere, fresh water, seawater and soils are briefly described. (L.C.L.)

6777 (EUR–4547) ABSORPTION OF HALOGENS, INTERHALOGENS AND FLUORIDES OF CERTAIN FISSION PRODUCTS ON SODA LIME. Del Bino, G. L.; Pierini, G. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). Nov 1970. 30p. (In Italian). (EURAEC–2141). Dep. NTIS (U. S. Sales Only). EUR Lit. 620,–.

An absorbent granular soda lime system was selected for treating gaseous effluents consisting mainly of chlorine, chlorine monofluoride, chlorine trifluoride, and fluorides of some fission products (Te, Nb, Mo, Ru). These gases are produced by irradiated nuclear fuel reprocessing plants whenever chlorine trifluoride is used as a fluorinating agent. As a result of experiments carried out in a soda lime-filled reactor it was possible to determine the useful absorption capacity versus the temperature, the linear velocity of the gas and the concentrations of the various halogens and interhalogens in nitrogen. The data obtained show that such an absorbent system has considerable potential applications and suggest that it may be used—apart from any technological problems which may arise in industrial-scale operation—to replace the traditional alkaline-solution scrubbers. (auth)

6778 (GKSS–71/E/1) SAFETY REPORT FOR HOT LABORATORY OF THE GEESTHACHT REACTOR. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Hamburg (West Germany)). 1971. 168p. (In German). Dep. NTIS (U. S. Sales Only).

The hot laboratory is located in the reactor building. It consists of an old cell section in operation since 1963 and the new hot cells built between 1968 and 1970. The laboratory contains four large concrete cells, a space with lead cells for technological, chemical, and metallographic work, and a warm workroom and installations for air samples and wastes. The laboratory was designed for the investigation of irradiation samples from the Geesthacht research reactor and spent fuel elements from the Otto Hahn reactor. A description of the installation, an operational outline, and safety considerations for the hot laboratory are presented. (tr-auth)

6779 (HMI-B–109) RESEARCH ON GLASSES FOR FISSION PRODUCT FIXATION. Summary Report, January 1968–June 1971. Heimerl, W.; Heine, H.; Kahl, L.; Levi, H. W.; Lutze, W.; Malow, G.; Schiewer, E.; Schubert, P. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Sep 1971. 97p. Dep. NTIS (U. S. Sales Only).

Research work, covering a period of three years, on glasses for fission product fixation is summarized. Leachability, leaching mechanisms, diffusion, glass composition, crystallization, and phase separation are discussed. (auth)

6780 (LA-DC–12683) GAMMA-RAY SCANNING SYSTEM FOR BARRELS CONTAINING PLUTONIUM WASTE. East, L. V.; Parker, J. L.; Reilly, T. D.; Walton, R. B. (Los Alamos Scientific Lab., N. Mex.). [1970]. 18p. (CONF-711111–7). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

A system designed to perform quantitative assay of plutonium waste material in 30 to 55 gal barrels is described. The system uses up to eight 2 in. × 2 in. NaI(Tl) detectors to make a detailed gamma ray scan of the barrel to be assayed. Barrels of 55 gal size containing ^{239}Pu waste and 30 gal barrels containing ^{238}Pu waste (from ^{238}PuO$_2$ isotopic heat source production) have been scanned with this system. Experience has shown that a barrel assay can be performed in 10 to 15 minutes to an accuracy of ±10%. The sensitivity of the system is one gram or better for ^{239}Pu or ^{238}Pu in low to medium density waste material. (auth)

6781 (ORNL–4633) MODEL FOR THE ECONOMIC ANALYSIS OF HIGH-LEVEL RADIOACTIVE WASTE MANAGEMENT. Dillon, R. S.; Perona, J. J.; Blomeke, J. O. (Oak Ridge National Lab., Tenn.). Nov 1971. Contract W-7405-eng-26. 79p. Dep. NTIS.

A computer program has been written to estimate costs of managing high-level radioactive waste from reprocessing power reactor fuels. The economic analysis encompasses interim liquid storage of the high-level fission product wastes, solidification (pot or fluidized-bed calcination), interim solid storage, shipment, and final storage in salt mines. Economic data obtained from each of the five waste management steps are subjected to a discounted cash-flow calculation using a specified rate of return to arrive at a levelized incremental power cost necessary to recover all waste management costs. The economic model is structured to perform either a government financing calculation or a calculation indicative of private financing. The program provides detailed cost summaries of the capital and operating expenses for each of the management steps, including the incremental power cost for each step. The total levelized cash flow required for the operation and the maximum unrecovered capital are also generated. Minimum total costs for five different schedules of waste management operations were calculated for a nominal 20,000-MW(e) nuclear economy of typical light water reactors. The lowest cost of 0.0329 mill/kWhr resulted from 20 yrs of liquid storage with no interim solid storage. The cost for 5 yrs each of interim liquid and interim solid storage was 0.0371 mill/kWhr. (auth)

6782 (SZS–10/71) CRITERIA FOR EVALUATION OF NUCLEAR AND RADIATION SAFETY OF SHIPPING CONTAINERS FOR IRRADIATED NUCLEAR FUELS. Albrecht, L.; Echhorn, H. (Staatliche Zentrale fuer Stranlenschutz, Berlin (East Germany)). May 1971. 20p. (In German). Dep. NTIS (U. S. Sales Only).

In the GDR (East Germany) shipping containers for irradiated nuclear fuels must be licensed by the National Centre for Radiation Protection. The grant of the licence is based on the judgement of the nuclear and radiation safety of the container. Principles for the judgement are compiled. According to these principles the Centre checks the submitted technical documents and gives necessary directives. A further purpose of these principles is to provide technical guidance for designers of shipping containers. (auth)

6783 (UCRL-73234) DISPOSAL OF RADIOACTIVE WASTE IN DEEP SILICATE ROCK. Cohen, J. J.; Lewis, A. E.; Braun, R. L. (California Univ., Livermore. Lawrence Radiation Lab.). 12 Oct 1971. 11p. (CONF-711111-10). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

A method for disposing of nuclear-reactor wastes by in-situ incorporation in molten silicate rock is presented. In this method, liquid wastes are injected into a deep underground chimney and allowed to self-boil. The resulting steam is processed at the ground surface and recycled into a closed system. When waste addition is terminated, the chimney is allowed to boil dry, thereby solidifying the waste. The heat generated by the radioactive waste then melts the surrounding rock, which dissolves the waste. Finally, the rock refreezes, trapping the radioactivity in an insoluble rock matrix deep underground. This method has significant environmental and economic advantages over previously proposed methods. (auth)

6784 PRINCIPLES OF CRITICALITY SAFETY IN HANDLING AND PROCESSING FISSILE MATERIALS. ISO R 1709 1970(E). International Organization for Standardization (1970). 4p. Available from American National Standards Institute, New York.

These criticality safety principles apply to all operations with fissile materials outside the cores of nuclear reactors but within the boundaries of nuclear establishments. They are concerned with the limitations which must be imposed on processes and equipment because of the unique nuclear properties of these materials by which they can support nuclear chain reactions. These principles apply to quantities of fissile materials in which nuclear criticality can be established. This ISO Recommendation states the factors and technical criteria which form the basis on which the procedures relating to criticality safety should be established. It does not cover details of equipment design or of operational procedures, nor does it refer to the effects of radiation on man or materials or to sources of such radiation, either natural or the result of nuclear chain reactions. Transport of fissile materials outside the boundaries of nuclear establishments should be governed by appropriate national and international regulations. (auth)

6785 APPARATUS FOR TRANSFERRING AN IRRADIATED SAMPLE FROM A SAMPLING STATION TO A STORAGE STATION. Aujard, Michel; Morin, Henri (to Commissariat a l'Energie Atomique). British Patent 1,243,935. 25 Aug 1971. Priority date 21 Feb 1969, France.

An apparatus is described for automatically transferring irradiated samples at low temperatures from sampling stations to remote storage stations. A movable carriage on a guide rail inclined from the sampling station to the storage station is controlled by a motor-driven drum around which is a cable which is also attached to the sample. The sample is carried by the cable-controlled carriage from the sampling station to the storage station. (J.R.D.)

6786 APPARATUS FOR TRANSFERRING IRRADIATED SAMPLES. Blaix, Noel; Lequeux, Germain; Zabe, Bernard (to Commissariat a l'Energie Atomique). British Patent 1,245,557. 8 Sep 1971. Priority date 19 Aug 1969, France.

An apparatus for transferring irradiated samples in swimming pool reactors is described. The apparatus comprises a shielded duct immersed in the water and remote equipment for transfer of cartridge-containing samples through the duct. The cartridge may be transferred to another site through the duct or removed and stored in a drum. (J.R.D.)

6787 DEVICE FOR ENCAPSULATING A RADIOACTIVE RESIN-WATER SLURRY. (to Westinghouse Electric Corp.). British Patent 1,240,635. 28 Jul 1971. Priority date 21 Jan 1969, United States.

The device comprises an outer container incorporating an inner container spaced from the outer container forming a chamber. A conduit is fitted through the outer and inner containers which extends into the chamber. A dry powder which sets on contact with water is placed in the chamber. Water from the resin-water slurry in the inner container is absorbed through openings by the powder forming a solid encapsulating material. (J.R.D.)

6788 RADIATION MONITORING SYSTEM FOR NUCLEAR POWER PLANTS. Iwai, Masaru (Mitsubishi Electric Corp., Kobe, Japan). Mitsubishi Denki Giho; 45: No. 3, 373-8(Mar 1971). (In Japanese).

As nuclear power generating facilities become more numerous and larger sized, the radiation monitoring system becomes increasingly important as a measure for preventing radiation damage, for early detection of reactor plant operations abnormalities, and for preventing accidents. A three-part system consisting of process radiation monitoring, area monitoring, and outdoor monitoring is described. The process radiation monitor is inserted in the secondary process line to monitor operation, to provide for early detection of accidents, and to prevent accident growth. The area monitoring equipment measures radiation levels inside the plant facilities in order to detect failure in any part of the plant and to provide for the safety of plant personnel. The outdoor monitors measure the radiation at the plant site, i.e. environmental contamination. The devices used for each type of monitoring, particularly for applications involving PWR's, are described. (Japan)

6789 TEST STORAGE OF WEAKLY RADIOACTIVE WASTE PRODUCTS IN THE ASSE SALT MINE. Kuehn, Klaus; Albrecht, Egon (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Munich). At. Strom; 17: No. 7-9, 134-7(Jul-Sep 1971). (In German).

The Radiation and Environment Research Co., in a test program extending over several years has stored low-level radioactive waste products in their salt mine at Asse. The aim of this test program was to use the deposition technology which had been worked out, and to devise further plans for disposal. (auth)

ENVIRONMENT AND EARTH SCIENCE

Geology and Hydrology

Refer also to abstracts 6530–6532, 6775, 6818, and 7734.

6790 (BNWL-B-110) FOREIGN AND DOMESTIC DISCUSSIONS ON NATURAL GEOTHERMAL POWER AND POTENTIAL USE OF PLOWSHARE TO STIMULATE THESE NATURAL SYSTEMS. Burnham, J. B.; Stewart, D. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 6 Jul 1971. 19p. Dep. NTIS.

A survey of the major geothermal areas of the world was conducted during May 1971. Visits were made to California, Australia, Hawaii, Iceland, Italy, and New Zealand to obtain first hand information from geothermal plant geologists, drillers, and plant operators and to discuss a proposed USAEC Plowshare Geothermal Stimulation research program. A summary is given of the geothermal resources of each country visited and included information on location, geology, production, power plant development, and future plans related to geothermal energy. (L.C.L.)

6791 (NVO-1229-171) INFILL OF NUCLEAR RUBBLE CHIMNEYS BY GROUND WATER. Fenske, Paul R.; Charnell, Robert L. (Teledyne Isotopes, Palo Alto, Calif.). Sep 1971. Contract AT(29-2)-1229. 33p. Dep. NTIS.

Some preliminary results are presented of a theoretical analysis of the ground-water infill rate of a rubble chimney produced by an underground nuclear explosion. The study was conducted to evaluate effects that various features of the hydrogeology regime have on rate of infill. This model for infill is based on the analogy of a rubble chimney to a small diameter gravity well. The infill history is approximated by integrating production from a series of steady state infill rates based on Dupuit–Forscheimer assumptions. The model has been used for parameter sensitivity analysis. Of the aquifer characteristics, changes of the hydraulic conductivity have the greatest effect on infill; the radius of influence is most sensitive to changes in the specific yield. The effect on infill rate using a rubble porosity that decreases with depth is small, although initial infill is more rapid. The hydrogeology data from two events where infill data are available have been used with this model for verification. For both Bilby and Greeley Events, agreement between measured and calculated infill data are good. Bilby data suggest that substantial dewatering of the rubble in the chimney occurred before much ground water entered the chimney. Comparison of the Greeley data indicates that dewatering of the rubble is minimal but that porosity of the rubble near the surface was higher than originally anticipated. (auth)

6792 (USGS-474-90) SUMMARY OF HYDRAULIC TESTING IN AND CHEMICAL ANALYSES OF WATER SAMPLES FROM DEEP EXPLORATORY HOLES IN LITTLE FISH LAKE, MONITOR, HOT CREEK, AND LITTLE SMOKY VALLEYS, NEVADA. Dinwiddie, George A.; Schroder, LeRoy J. (Geological Survey, Denver, Colo.). 1971. Contract AT(29-2)-474. 70p. Dep. NTIS.

Hydraulic-test data obtained in deep exploratory holes in central Nevada are summarized. The tests were designed to determine vertical variations in head, transmissivity, hydraulic conductivity, storage coefficient, velocity of ground-water movement, and chemical quality of water in selected intervals of the boreholes. Valley fill of Quaternary and Tertiary age, volcanic rock (tuff and rhyolite) of Tertiary age, and carbonate rock (dolomite) of Paleozoic age are penetrated by the boreholes which range in depth from 2,963 feet (903.1 meters) to 7,978 feet (2,432 meters). Hydraulic tests were not made in carbonate rock. In those tested intervals from which the data were adequate for analysis, transmissivity ranged from 3.53×10^3 to an estimated 1.1×10^{-3} gallons per day per foot or 4.38×10^1 to 1.4×10^{-5} cubic meters per day per meter; relative specific capacity ranged from 0.67 to an estimated 3×10^{-6} gallons per minute per foot of drawdown or 12.0 to 6×10^{-5} cubic meters per day per meter of drawdown; hydraulic conductivity ranged from an estimated 50.2 to an estimated 3.7×10^{-6} gal per day per ft^2 or 2.05 to 1.5×10^{-7} m^3 per day per m^2; and velocity ranged from an estimated 3.3×10^{-1} to an estimated 1.5×10^{-8} ft per day or 1.0×10^{-1} to 4.5×10^{-9} m per day. Velocities of ground-water movement through some intervals, however, might be significantly greater, depending on the thickness and the effective porosities of the water-contributing fracture systems. (auth)

6793 ISOLATION AND SIZE FRACTIONATION OF MICROPARTICULATE MATTER SUSPENDED IN THE COLUMBIA RIVER. Wildung, Raymond E.; Routson, Ronald C.; Schmidt, Ronald L. (Battelle-Northwest, Richland, Wash.). Northwest Sci.; 45: No. 3, 133-6(Aug 1971).

In order to evaluate the influence of suspended particle size on the behavior of radionuclides and pesticides in the Columbia River, a centrifugation technique was devised that allowed size fractionation of suspended particulate matter in the micron and submicron size ranges in quantities sufficient for further studies of isolated fractions but without harsh chemical treatment that might alter the properties of the individual components. The isolation method, designed for waters of low suspended sediment concentration, should be particularly applicable to surface waters of the Northwest. (auth)

6794 RADIOACTIVE PRECIPITATES IN TAMAGAWA AND MISASA HOT SPRINGS. Saito, Nobufusa (Tokyo Univ.). Chigaku Kenkyu; 21: No. 11-12, 387-92(Dec 1970). (In Japanese).

The properties of radioactive precipitates in the Tamagawa and the Misasa hot springs, were studied. The radioactive precipitates in the Tamagawa hot spring, Akita Pref., which were discovered in 1950, are sublimed sulfur, and it was found that their appreciable radioactivity is solely due to minute hokutolite crystals included in them, and the sulfur itself is non-radioactive. The Hokutolite is well-known as a strongly radioactive mineral deposited from the Tamagawa hot springs. The radioactive precipitates in Misasa hot springs, Tottori Pref., also discovered in 1950, are manganiferous, and covered surfaces of gravels in thin layers, near opening of OTR spring. In this case, also, radioactive elements seemed to be precipitated together with manganese. (Japan)

6795 DETERMINATION OF THE WATER PROFILE OF A SOIL COLUMN USING THE ATTENUATION OF A γ RAY BEAM. Rahmouni, O. (Institut d'Etudes Nucleaires, Algiers). Mes., Reg., Automat.; 36: No. 8-9, 102-6(Aug-Sep 1971). (In French).

The method proposed enables the water content of 3 mm thick soil layers to be measured without disturbing the soil column: a narrow (1 mm diameter) γ ray beam from a ^{137}Cs source is used; the swelling of the sample is measured using γ ray emitting ^{60}Co microsources. The water contents of the soils were determined within 3%. The results enable an overall value, which is in agreement with that determined by classical methods, to be obtained as well as the water profile and its variation with time. (France)

6796 TRITIUM IN GROUND WATER AND GLACIERS IN ICELAND. Theodorsson, Pall. Joekull (Reykjavik); 18: 350-8(1968). (In Icelandic).

Main results of tritium measurements in two boreholes in the Langjökull glaciers are tabulated. There is extensive isotopic exchange between rain and melt water and ice of Langjökull. The Bardarbunga glacier is found to be arctic or very nearly so; therefore, it should be possible to obtain a continuous record of the H_3 concentration in precipitation during the last decades, before contamination by hydrogen bombs, from a deep core in this glacier. (Geophys. Abstr.)

6797 URANIUM AND THORIUM AS INDICATORS OF PROCESSES OF FORMATION OF PYRITE–POLYMETALLIC ORES ON THE MAIKAIN DEPOSIT (CENTRAL KAZAKHSTAN). Syromyatnikov, N. G.; Trofimova, L. A.; Yarenskaya, M. A. (Inst. of Geological Sciences, Alma-Ata, USSR). Geokhimiya; No. 7, 846-54(Jul 1971). (In Russian).

The uranium and thorium distribution in sulfur-pyrite (1st stage), copper–pyrite and baryte–polymetallic (two phases of the 2nd stage) ores has been studied. Sulfurpyrite ores were characterized by the lowest uranium and thorium contents. In copper–pyrite and baryte–polymetallic ores uranium content was on the average much higher. It increased with an increase in the amount of ore minerals, and chiefly, of pyrite. Thorium concentration and the Th/U ratio in the ranges of the whole ore body were very low irrespective of the content of ore minerals. A zoning of uranium and thorium distribution in the ore body and the country rocks was noticed. The results obtained were accounted for by the change of physicochemical properties of postvolcanic gases–solutions at different stages of the volcanogenic-hydrothermal (metasomatic) ore formation. (auth)

6798 GEOFIZICHESKAYA APPARATURA. BYPUSK 45. (Geophysical Apparatus. Issue No. 45). Vikulin, B. K. (ed.). Leningrad; Izdatel'stvo Nedra Leningradskoe Otdelenie (1971). 208p.

This collection of 35 papers by various authors is grouped according to the following fields of magnetometry, radiometry, well logging, and a miscellaneous group: exchange of experience. Of chief interest here are several papers on gamma-gamma well logging wave electromagnetic well logging, and x ray radiometric analysis of light elements. (K.S.W.)

6799 PLUTONIUM CONTENT OF SOIL AT NAGASAKI. Sakanoue, M.; Tsuji, T. (Kanazawa Univ., Japan). Nature (London): 234: No. 5324, 92-3(12 Nov 1971).

Samples of soil were taken in July 1969 from less disturbed ground surfaces and the amount of Pu remaining in the soil after 24 years was determined. Details are given of the analytical method employed and data are tabulated for ^{239}Pu, ^{238}Pu, ^{238}Pu/^{239}Pu, and ^{90}Sr. The results may be important for further studies of environmental radioactivity since they show that Pu contaminants in soil are not readily renewed naturally. (UK)

6800 POSSIBILITIES OF USING NEUTRON GAMMA LOGGING IN MONITORING GAS FIELDS DURING EXPLOITATION. Berman, L. B.; Dvorkin, L. B. Razved. Geofiz; No. 34, 117-26(1969). (In Russian).

An analysis is given of the correlational transformation method for reducing neutron-gamma logs to unit conditions. It is shown that with the use of this method, the reliability of detection of formations with varying gas saturation from such logs, taken at different times, is somewhat greater than 95 percent. (Geophys. Abstr.)

6801 RECENT RESULTS OF RADIOACTIVE MEASUREMENTS ON BOREHOLE MODELS. Andrassy, Laszlo; Meszaros, Ferenc; Uhlmann, Norbert. Geofiz. Kozlem.; 19: No. 1-2, 23-32(1970). (In Hungarian).

The procedure and calibration of two-detector gamma-gamma logging equipment on drill hole models, and the calibration curve and a nomogram for determining density, are described. The apparatus is described briefly, problems of neutron logging are considered, and some results are presented. (Geophys. Abstr.)

Meteorology

Refer also to abstracts 6530–6532, 6775, and 7018.

6802 (AEC-tr-7268) RADIOACTIVITY OF THE ATMOSPHERE. Makhon'ko, K. P. (ed.). Translation of report CONF-680733. 160p. Dep. NTIS.

Survey lectures are published concerning the research findings in the study of manmade and natural radioactivity in the atmosphere. The participants included the hydrometeorological services of the Hungarian Peoples Republic, German Democratic Republic, USSR and Czechoslovakian SSR. The lectures were presented at a symposium held during the Fifth Session of the Working Group of experts from the socialist countries on radioactivity of air and atmospheric fallout. The information is intended for use by specialists in the field of nuclear meteorology, workers in the Hydrometeorological Service, scientific workers, research students and other students concerned with the field covered. (auth)

6803 (NP–19124) INFLUENCE OF CHINESE NUCLEAR WEAPONS TESTS ON THE RADIONUCLIDE CONCENTRATION IN THE AIR NEAR THE EARTH. Kolb, W. (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). Jul 1971. 30p. (RA–1/71). Dep. NTIS (U. S. Sales Only).

The activity concentrations of ^{54}Mn, ^{106}Ru, ^{125}Sb, ^{137}Cs, and ^{144}Ce in surface air were measured from 1963 to 1971. Filters containing dust were ashed and the different radionuclides radiochemically separated. Each fraction was measured in a NaI(Tl) scintillation spectrometer. Some ^{57}Co, ^{65}Zn, ^{95}Zr + ^{95}Nb, ^{103}Ru, and ^{141}Ce measurements were also made. The following results were obtained: fresh fission products were detectable after each nuclear test. A very sharp increase was observed for ^{95}Zr + ^{95}Nb immediately after Test no. 3. Within one month (5/66), the concentration increased from 0.04 to 40 fCi/m^3; the activity concentrations of radionuclides having half lives >200 d were influenced very little by Tests no. 1 to 5. The pronounced spring maxima decreased from year to year. First after Test no. 6 (first Chinese thermonuclear test) the spring maximum in 1968 reached values in the order of those in 1965. The maxima in 1969 and 1970 caused by the second and third thermonuclear test (no. 8 and 10) were slightly higher; some induced radionuclides were analyzed. While ^{54}Mn was produced by Tests no. 6, 8 and 10, ^{65}Zn stems exclusively from no. 6 and ^{57}Co from no. 8 and 10; and the activity concentrations of all investigated nuclides were at least three orders of magnitude lower than those which can be derived from the dose limits for the whole population. The most critical nuclides in this respect were ^{144}Ce, ^{106}Ru, and ^{95}Zr. (auth)

6804 QUANTITATIVE EVALUATION OF LOW LEVELS OF ^{131}I IN AIR IN NUCLEAR POWER REACTOR SYSTEMS. Furtado, Victor C. New York; New York Univ. (1970). 284p. University Microfilms Order No. 71-23,043.

Thesis.

A system has been designed to determine ^{131}I at or near Maximum Permissible Concentrations (MPC) in reactor environments. It can be readily used by nonprofessional personnel to obtain reliable determinations of total ^{131}I concentrations, even under adverse environmental conditions. This system also provides a semi-quantitative species determination (molecular vs organic iodine). The utility of this system has been demonstrated in a field test at an operating nuclear power reactor. The presence of a third species of iodine, previously unsuspected, was clearly demonstrated, and the species tentatively identified as hypoiodous acid. Adsorption parameters have been studied for systems involving methyl iodide, iodine, water vapor and air in the gas phase, and two types of charcoal as the adsorbant. To conduct these experiments, a new method for producing high specific activity $CH_3{}^{131}I$ was devised, as well as systems for generating controlled test environments at 1 to 200 MPC. The adsorption efficiency of two activated coconut charcoals for methyl iodide was determined in a variety of test environments. Methyl iodide concentration varied from 7.2×10^{-8} μg/m^3, with most experiments in the range 1 to 200 MPC (7.2×10^{-8} to 1.4×10^{-8} μg/m^3). Relative humidity varied from 61 to 88%. Adsorbed water on the charcoal bed was as high as 0.675 grams of water per gram of charcoal. Contact time and temperature remained essentially constant. One charcoal was of the iodine-impregnated type. Adsorbed bed water was the controlling variable, with relative humidity a significant, but secondary, factor. On the nonimpregnated charcoal, adsorbed bed water and relative humidity were of equal importance. This clear distinction results from differing removal processes. On the noniodized charcoal, both variables interfered with adsorption. Bed water reduces available surface area and actually fills the smaller pores, while water vapor gives methyl iodine gas phase competition for the available active sites. On the iodine-impregnated charcoal, both exchange reaction and adsorption take place, with exchange dominant. Bed water reduces available surface area for both exchange and adsorption, but water vapor does not affect the exchange reaction. In the concentration range 1 to 200 MPC, no significant concentration effect was found for either charcoal. However, over ten orders of magnitude of concentration, the nonimpregnated charcoal demonstrated a slight decrease in efficiency with increase in concentration. (Diss. Abstr. Int., B)

6805 ATMOSPHERIC RADIOACTIVITY IN CZECHOSLOVAKIA IN 1968 AND 1969. Kolarova, H.; Santroch, J. (Inst. of Hydrometeorology, Prague). Meteorol. Zpr.; 23: No. 5, 130-40(31 Oct 1970). (In Czech).

The results are presented of the measurements of the total β-radioactivity of the atmosphere and of the daily, weekly and monthly fall-out in 1968 and 1969. A brief meteorological analysis is given of the extremes of atmospheric radioactivity. (NSA of Czech)

6806 OBSERVATIONS OF RADIOACTIVITY. Helsinki; Finnish Meteorological Institute (1971). 70p.

Measurements of beta activity in air at ten places in Finland, as well as measurements of beta activity in precipitation and settled dust collected at Helsinki and Ivalo, are reported. Information about measuring methods and sampling sites is given. Hourly values and mean diurnal variation of short lived (less than four hours) aerosol beta activity are tabulated. Daily and weekly values for fraction of aerosol beta activity remaining four days after and of sampling period are given. (Finland)

6807 VERTICAL PROFILES AND TRANSPORT OF HTO IN THE TROPOSPHERE. Ehhalt, D. H. (National Center for Atmospheric Research, Boulder, Colo.). J. Geophys. Res.; 76: No. 30, 7351-67(20 Oct 1971).

Water-vapor samples were collected from the surface to 9.2-km altitude over Scottsbluff, Nebraska from November 1965 to January 1967 and over the eastern Pacific and Death Valley from July 1966 to August 1967. During spring, the resulting profiles of the T/H ratio generally showed an increase with altitude. However the mixing ratio of tritiated water vapor decreased with altitude, reached a minimum at 7 km, and increased again above that level. The shape of the mixing ratio profile was found to be a product of the vertical transport of HTO by precipitation and eddy diffusion and two source regions of HTO vapor: the tropopause and the continental surface. The profile was further modified by two processes. Below the freezing level at around 3 km, ice crystals falling from above injected their high T content into the environmental water vapor which acted as a source of HTO vapor. Below 2 km, horizontal advection of oceanic air with lower T content played a role. The profiles showed also that in 1966 the influence of HTO re-evaporated from the continental surface was limited to altitudes below 2 km. The re-evaporated HTO nevertheless considerably modified the seasonal variation of the T content in rain even over the oceans. The theoretical shape of the steady-state profile above the freezing level was calculated and fitted to the experimental data for the mixing ratio. The resulting vertical profile for the average mixing ratio in spring 1966 was $(M) = 4.4 \cdot 10^6 \cdot \exp[(z - 3.37)/1.91] + 1.47 \cdot 10^8 \cdot \exp[(z - 3.37)/2.42]$ [HTO molecules/kg air] where z is the altitude above ground in kilometers. (auth)

6808 OBSERVATION OF RADIORUTHENIUM AND RADIOCERIUM ISOTOPIC ACTIVITY RATIOS IN RAIN WATER DURING 1970. Mamuro, Tetsuo; Matsunami, Tadao. Annu. Rep. Radiat. Center Osaka Prefect.; 11: 36-9(1970).

As a result of the observation on the variation with time of isotopic activity ratios of ^{103}Ru to ^{106}Ru and ^{141}Ce to ^{144}Ce in rainwater during 1970, it was concluded that the nuclear debris injected into the stratosphere by the Chinese nuclear explosion of September 29, 1969, became noticeable in rainwater in Japan rather abruptly in February, 1970, about 150 days after the explosion. It was also concluded that the fresh tropospheric debris produced by the series of French nuclear explosions carried out in the southern hemisphere from May to August, 1970 reached Osaka about 50 days after explosion. Moreover, towards the end of 1970 the two ratio values in rainwater increased remarkably, being influenced by the Chinese nuclear explosion of October 14, 1970. It appears that the variation of the radioruthenium activity ratio is more sensitive to detecting long range or stratospheric fallout of 50 to 200 days age than that of the radiocerium activity ratio, possibly because of the fractionation effect in nuclear debris. (auth)

Mineralogy and Exploration

6809 AMOUNT OF MOBILE URANIUM IN EFFUSIVE AND INTRUSIVE ROCKS OF THE EASTERN MARGIN OF THE SOUTH-MINUSINSK DEPRESSION. Kovalev, V. P.; Malyasova, Z. V. (Inst. of Geology and Geophysics, Novosibirsk, USSR). Geokhimiya; No. 7, 855-65(Jul 1971). (In Russian).

As a result of selective uranium leaching from intrusive and effusive-rocks covering a wide range of petrochemical compositions, it was found that effusives are practically devoid of easily mobile uranium. Glasses obtained after intrusive rock fusion just as firmly retained uranium. This was accounted for by the more regular distribution of uranium in a disperse and dissolved form in the chief vitreous mass of out-flown rocks, as well as by the formation under the solvent action of screening silicic gel films on the particle surfaces which prevent uranium diffusion. This fact must be taken into consideration when the idea of possible uranium mobilization by hydrothermal solutions from igneous rocks is developed. (auth)

6810 ROESSING URANIUM DEPOSIT IN SW AFRICA. Com. Naz. Energ. Nucl., Notiz.; 17: No. 7, 70-4(Jul 1971). (In Italian).

A description is given of what is now regarded as potentially the largest uranium deposit in Southwest Africa. (auth)

6811 REGULARITIES IN THE DISTRIBUTION AND MIGRATION OF URANIUM AND THORIUM IN ORES OF THE EARTH'S CRUST. Smyslov, A. A. Tr. Vses. Nauch.-Issled. Geol. Inst., 164: 5-32(1968). (In Russian).

From extensive data in the literature it was possible not only to estimate the contents of uranium and thorium in various types of ores, but also to bring out general regularities in the behavior of these elements (mainly temporal regularities) in the course of sedimentary accumulation, magma formation, and metamorphism. Figures for U and Th are given in 10^{-4}% with the range in parenthesis. For sedimentary deposits in mountainous regions the distribution of U and Th was as follows for initial geosynclinal bending in sand-clay deposits: carbonaceous enriched in organic matter U = 4.1 (2 to 10), Th = 8, and Th/U = 2.0; sand-silica slates U = 2.1 (1.5 to 3.0), Th = 8.8 (5.4 to 15.3), and Th/U = 4.1; jasper quartz U = 2.0 (1.5 to 2.7), Th = 2.5 (1.0 to 3.3), and Th/U = 1.3; sandstone U = 2.1 (1.0 to 2.9), Th = 10.3 (4.8 to 17.7), and Th/U = 4.9. At the state of late geosynclinal bending (internal geosynclinal bends) the figures were as follows: argillites U = 2.7 (1.6 to 4.4), Th = 7.0 (5.1 to 10.0), and Th/U = 2.6; sandstone U = 2.4 (1.5 to 2.9), Th = 2.2 (4 to 10), and Th/U = 3.0; conglomerates U = 1.5 (1.1 to 2.0), Th = 7, and Th/U = 4.6. In late orogenic formations the following values were obtained (mainly on red deposits): argillites U = 3.0, Th = 9.6, and Th/U = 3.2; sandstone U = 2.4, Th = 11.6, and Th/U = 4.8. With limestone U = 1.3, Th = 0.4, and Th/U = 0.4. In igneous rock the contents were as follows: serpentine (geosynclinal) U = 0.05 to 0.3, Th < 1, and Th/U = 3; quartz porphyry U = 1.8, Th = 3.0, and Th/U = 1.6; gabbro-diorites U = 1, Th = 4.0, and Th/U = 4.0; biotite granite U = 4.7 (3.3 to 6.7), Th = 28.5 (9.0 to 38.0), and Th/U = 6.0 (3.0 to 7.0); andesite porphyry U = 2.5, Th = 10.0, and Th/U = 4.0. Values are also given for crystalline rocks at various phases of metamorphism and for hydrothermal metamorphism. (TTT)

6812 ARLETTE URANIUM DEPOSIT OF ARLIT IN NIGER. Baudet, J.; Bizard, C. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Rev. Ind. Minerale; 53: No. 5, 355-66 (May 1971). (In French).

The prospection of the Arlette uranium deposit is reviewed. The local stratigraphy and the Tarat–Madaouela facies were investigated. The methods for prospecting and localizing the deposit in the local structural formations are described. Sandstone deposits were principally obtained in the first sedimentation period of the Tarat–Madaouela which contains the Arlette deposit; alternate clay and sandstone layers containing the main mineralization were obtained in a second period. (France)

6813 SUMMARY REPORT ON RADIOACTIVE INTENSITY DISTRIBUTION IN NORTHERN REGION OF AKITA PREFECTURE. Horikawa, Yoshio (Geological Survey of Japan, Kawasaki). Chishitsu Chosasho Geppo; 21: No. 12, 709-10(Dec 1970). (In Japanese).

In a period from middle of July to early August 1965, a general survey for radioactive intensity distribution with car-borne instruments was performed over an area covering the northern region of Akita Prefecture and the southwestern part of Aomori Prefecture, for the purpose of exploring nuclear resources. The main instrument used was a car-borne scintillation counter. The surveyed area was approximately 3,000 km^2. The measured distance totaled 830 km. The outline of the radioactivity of rocks and formations distributed in the area was realized by plotting the radioactive intensities measured over the area, but the location of a radioactive anomaly deserving further precise survey was not found. Basement rocks in this region are pre-Tertiary slates and granites. The latter exposed near the prefecture boundary show the intensity of 500 to 600 counts per second. Neogene Green Tuff formation and accompanying volcanic rocks cover most parts of the region. The former is distributed in the vicinity of Odate and other places and shows an intensity as low as 200 to 400 counts per second. Only some rhyolites, dacites, and acidic pumiceous tuffs in the surveyed area show somewhat higher intensity of 500 to 700 counts per second. (Japan)

6814 DISTRIBUTION OF URANIUM, THORIUM, FLUORINE, CHLORINE, MOLYBDENUM, AND NIOBIUM IN LIPARITES AND ACID VOLCANIC GLASSES. Shatkov, G. A.; Shatkova, L. N.; Gushchin, E. N. Geochem. Int. (Engl. Transl.); 7: No. 6, 1051-63(Nov 1970).

Translated from Geokhimiya; No. 11-12, 1051-63(Nov-Dec 1970).

Differences in the contents of rare elements in separate volcanic centers are explained, apparently, by the following main factors: non-uniformity of the phenomena of the process of tectono-magmatic activation; geochemical heterogeneity of the fusion undergone by the substratum; and specific processes of magmatism in each volcanic center. Intratelluric crystallization favors the accumulation of uranium in the residual melt, especially under conditions of high concentrations of fluorine. The crystallization (felsitization) of magmatic melts under surface conditions is accompanied by loss of uranium, molybdenum, fluorine, and chlorine. The intensity of the loss of uranium is determined by its content in the melt, the amounts of fluorine and other volatile components, and the degree of oxidation of the uranium. One can assess the potential ore-bearing capacity of a given volcanic structure from knowledge of the intensity of the process of carrying away the rare elements from the crystallizing melt. The source of ore material for deposits associated with volcanogenic formations can probably be not only deep magmatic chambers, but also the specific extrusive and surface facies of volcanic rocks. (auth)

Oceanography

Refer also to abstracts 6581 and 6775.

6815 SALT WATER CHLORINE ION DETERMINATION BY NEUTRON-CAPTURE GAMMA RAYS. Wiggins, Peter F.; Athow, Karl J (Naval Academy, Annapolis, Md.). Nav. Eng. J.; 83: No. 5, 88-92(Oct 1971).

Identification of ocean flow patterns is of interest to ocean engineers because of their effects on ocean current diffusion. The change in salinity in the ocean near where a fresh water river enters the sea is of particular interest. In addition, a rapid, accurate method of chlorine concentration measurement could be helpful in sonar detection applications i.e., location of inversion layers. The feasibility of using the neutron-capture gamma rays produced by chlorine, as an in-situ method for which salinity contours could be obtained is discussed. The bending of these contours shows the current flow. (auth)

Seismology

6816 (NVO-1163-227) PRELIMINARY CONSIDERATIONS OF GROUND MOTION FROM A VERTICALLY ORIENTED MULTIPLE DETONATION. Power, F. W.; Williams, S. L. (Environmental Research Corp., Las Vegas, Nev.). Nov 1971. Contract AT(29-2)-1163. 73p. Dep. NTIS.

Finite difference calculations were performed with the SHELP elastic wave propagation code to compare ground motions from vertically oriented multiple nuclear detonations in a half-space with ground motions from a corresponding single detonation of the same total yield. Computations were performed at depths of 0.75 km and 2.25 km. Two vertically oriented multiple detonations were studied for cases where the fracture regions overlapped and where they were separated. Detonation of one of the two charges a few milliseconds later than the other was also studied for the case of overlapping elastic radii. In addition, calculations were performed for three vertically oriented charges with overlapping fracture regions. The calculations indicate minor differences in the ground motion generated by single and multiple detonations. Motions due to the detonation of the shallow charges varied due to differences in the depth of burial. The shallow multiple charges exhibited larger spectral bandwidths than the single charge. Both the shallow and deep multiples had spectral amplitudes less than those for the corresponding single charge up to a frequency of about 4 Hz but, in many cases, exhibited greater spectral amplitude than the single charge above about 8 Hz. These differences diminished with range. The ground motions from the various multiple detonations are very similar. Due to the lack of detailed knowledge of the seismic source function for multiple detonations, these results are considered preliminary. (auth)

6817 (NVO-1163-228) PREDICTIONS OF GROUND MOTION, RIO BLANCO EVENT. (Environmental Research Corp., Las Vegas, Nev.). Nov 1971. Contract AT(29-2)-1163. 64p. Dep. NTIS.

Ground motion predictions were made for the Rio Blanco Event. The ground motion predictions consist of: Pseudo-Relative Velocity (PSRV) spectra at selected locations and distances; peak vector acceleration, velocity and displacement for selected locations and as a function of distance; and peak horizontal component acceleration, velocity and displacement at selected locations. The procedures and data used to make the ground motion predictions are described. The equivalent seismic source for Rio Blanco is taken to be a single detonation with an elastic radius which bounds the predicted nonlinear region associated with the multiple detonation. The single source defined by this criterion has a yield of 123 kt and a depth of burial of 6373 feet. The uncertainties in the mean predictions are estimated by combining the distribution of the observed Rulison data with previously defined measures of source variability using well established statistical techniques. (auth)

6818 CRUSTAL TRANSFER RATIOS OF SHORT- AND LONG-PERIOD BODY WAVES RECORDED AT YELLOWKNIFE. Hasegawa, H. S. (Dept. of Energy, Mines, and Resources, Ottawa). Bull. Seismol. Soc. Amer.; 61: No. 5, 1303-20(Oct 1971).

A feasibility study into the spectral ratio technique of deducing crustal structure at Yellowknife indicates that through the use of long-period teleseismic body waves, the crustal thickness can be determined to within 4 km and the velocity to within 0.6 km/sec of the values obtained by a reversed refraction profile and through the use of short-period body waves, a thin (a few km thick) layer near the surface with a velocity contrast of about 10% with that of the underlying layer can be detected. Theoretical considerations indicate that long-period body waves are not modified, to any significant extent, by absorption in the crust (representative Q values from 75 to 200) but that short-period body waves are. However, estimates of a mean Q for the crust at Yellowknife through the use of short-period body waves are inconclusive, due mainly to inconclusive data—that is, the spectral ratio curves for the different events shown do not agree. The advantages of incorporating multiple phases, such as pP and PcP, into the spectral ratio calculations for long-period body phases are more than offset by the increased intractability in deducing gross crustal features. In the present study, the theoretical composite spectral ratios are restricted to the case where equal amplitudes are assumed for P, pP and PcP, whereas, in the experimental seismograms selected, pP and PcP have smaller amplitudes. (auth)

6819 ENERGY RELEASED IN THE BENHAM AFTERSHOCKS. Crowley, Barbara K.; Germain, Lawrence S. (Univ. of California, Livermore). Bull. Seismol. Soc. Amer.; 61: No. 5, 1293-1301(Oct 1971).

The aftershock activity of the Benham explosion, which occurred over an area of 100 km^2 and lasted for several weeks, was far more intensive than that following Jorum and Handley. However, the radiated seismic energy of the aftershocks was only of the order of one-hundredth of the energy of Benham that coupled into seismic wave motion. The aftershock volume of Benham does not appear to be significantly different from the volume for aftershocks from a natural event of the same body-wave magnitude. (auth)

6820 COMPARISON OF LOVE- AND RAYLEIGH-WAVE MULTIPATH PROPAGATION AT LASA. Capon, Jack (Massachusetts Inst. of Tech., Lexington). Bull. Seismol. Soc. Amer.; 61: No. 5, 1327-44(Oct 1971).

An analysis was made of the multipath propagation of Love waves by using data obtained from the array of three-component instruments located at the Large Aperture Seismic Array (LASA). These data were analyzed by means of a high-resolution analysis technique, which provided a greater angular resolution and accuracy than was previously possible for the analysis of the multipath propagation of Love waves. The measurement of this phenomenon was made for the Love waves of six events distributed at various azimuths and distances from LASA. These measurements were used to make conjectures about the actual propagation paths for Love-wave groups in the 20 to 40-sec-period range. In addition, these paths were compared to the corresponding ones for Rayleigh waves, which were obtained previously. It is shown that in most cases, for both Love and Rayleigh waves, these propagation paths can be associated with refractions and reflections at the continental margins. (auth)

6821 SEISMIC MOTION RECORDED FROM THE MILROW DETONATION IN THE DISTANCE RANGE 7 TO 377 KM. Orphal, D. L. (Environmental Research Corp., Las Vegas, Nev.). Contract AT(29-2)-1163. Bull. Seismol. Soc. Amer.; 61: No. 5, 1467-71(Oct 1971).

The amplitude and spectral characteristics of the seismic motions recorded from the Milrow Event (1969 underground nuclear explosion on Amchitka Island) in the distance range of from 7 to 377 km are described and compared with data from underground nuclear explosions at the Nevada Test Site. It was found that the characteristics of the seismic motions recorded from Milrow in this distance range were very similar to those observed from high-yield NTS events. The seismic motions recorded from Milrow agreed well with predetonation predictions. The successful application of ground-motion prediction methodology based on experience with NTS detonations to the Milrow event suggests that ground-motion prediction techniques used for high-yield NTS events can be reliably applied to high-yield events at Amchitka. (L.C.L.)

6822 EARTHQUAKE OBSERVATION IN THE FUKUSHIMA NUCLEAR POWER STATION. Ohmatsuzawa, Kyoichi (Tokyo Electric Power Co. Inc.). Karyoku Hatsuden; 22: No. 1, 90-7 (Jan 1971). (In Japanese).

During construction of reactor No. 1 at the Fukushima Power Station seismometers were installed in a reactor building and underground. When two earthquakes with seismic centers in sea off Iwate and Fukushima Prefectures respectively, occurred in April and May 1970, the seismic records were obtained. The topography and observations are described. It was concluded that the scale of the earthquake off Iwate was larger than that off Fukushima; maximum acceleration in the foundation agreed with the seismic scale of the Meteorological Agency; the acceleration wave-form in the foundation was complex and the amplitude increased in the building; amplification of the acceleration from the ground to the foundation was slight, and when the observed value was extrapolated, the design value was found to be on the safe side. (Japan)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 6767 and 6788.

General Detectors and Monitors

Refer also to abstracts 6488, 6942, 7064, and 7605.

6823 (AD–715014) STUDY OF NEW RADIACMETER POWER SOURCES. Final Report, July 1968–June 1970. Sturman, Ivan P. (Trapelo/West, Richmond, Calif.). Contract DAHC20-68-C-0187. 44p. (TLW–6064). NTIS.

Characteristics of the power sources specified for OCD CDV-715 RADIACS were studied. A correlation was developed between D-cell age and the average number of hours that a D-cell can operate a CDV-715 continuously after the D-cells were stored. The storage was in RADEF kit locations typical of the contiguous 48 of the United States. The study experiments also included measurement of voltage under load at ambient and at the extreme temperatures specified as the operating limits of the CDV-715. The tests also were applied to several feasible substitutes for the cells now being supplied. Cost comparisons were made for a number of realistic alternate RADIAC power source supply procedures. Specific procedures and topics for further study are recommended. (auth)

6824 (AD–718737) RADIAC SURVEY INSTRUMENTATION. Materiel Test Procedure. (Army Test and Evaluation Command, Aberdeen Proving Ground, Md.). 10 Jun 1969. 16p. (MTP–8-2-172). NTIS.

The objective of this material test procedure is to prescribe engineering test procedures to determine the technical performance and safety aspects of radiac survey instrumentation relative to the criteria cited in applicable Qualitative Material Requirements (QMR), Small Development Requirements (SDR), Technical Characteristics (TC), and other applicable requirements and documentation, and determining their suitability for an intended use. (auth) (USGRDR)

6825 (BNWL-SA-3936) POSITION SENSITIVE PROPORTIONAL COUNTER FOR NEUTRON RADIOGRAPHY. Swinth, K. L.; Crowe, J. C. (Battelle Pacific Northwest Labs., Richland, Wash.). [1971]. 15p. (CONF-711111–12). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

A prototype position-sensitive proportional counter was investigated for use in neutron imaging applications. The counter uses a converter foil of ^{6}LiF and a collimation grid to achieve improved resolution compared to counters filled with a neutron-sensitive counting gas. The proportional counter consists of a grid of 36 1-mil pyrolytic carbon coated quartz fibers on 2.5 mm centers. Because of the high resistance of the collector wires and the distributed capacitance to ground, the rise time of a pulse will increase with distance along the collector. This rise-time information is used to determine the position of an event to accuracies less than 1 mm along the wire. Standard nuclear instrumentation techniques are utilized with readout on a multichannel pulse height analyzer or on a storage scope. Tests performed with alpha particles showed that a geometry using collector wires off center by 0.5 mm produced the best resolution. The best resolution achieved was 0.59 mm FWHM, but the off-center geometry was not used for the neutron imaging experiments because of difficulties in achieving stable operation. Neutron images produced by this counter had an unsharpness of 5.5 mm (3.3 mm FWHM) and a contrast of 55%; this was with a ^{6}LiF converter foil (100μ). Images with ^{10}B and Gd converter foils showed unsatisfactory contrasts. (auth)

6826 (CEA-CONF–1840) VERY-HIGH-RESOLUTION NONDISPERSIVE X-RAY SPECTROMETRY WITH COOLED Si(Li) DETECTORS AND OPTOELECTRON PREAMPLIFIER. Friant, Alain (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1971. 11p. (In French). (CONF-710937–1). Dep. NTIS (U. S. Sales Only).

From International conference on x ray analytical methods; Toulouse, France (6 Sep 1971).

Nondispersive x-ray spectrometers allow the simultaneous analysis of all the lines present, with a resolution higher than any other pulse detector. The quality of the silicon used has been greatly improved. Optoelectron feedback preamplifiers whose resolution reaches a hundred eV have been developed. (France)

6827 (LA-DC–12766) SHIRX: A HIGH-RESOLUTION ROCKET-BORNE X-RAY SPECTROMETER. Singer, S.; Aiello, W. P.; Bergey, J. A.; Edeskuty, F. J.; Williamson, K. D. (Los Alamos Scientific Lab., N. Mex.). [1971]. 8p. (CONF-711111–19). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

A rocket-borne x-ray spectrometer is described which used cooled lithium-drifted semiconductor detectors to measure the differential x-ray energy spectrum of Sco XR-1 in the range 0.6 to 20 keV. (auth)

6828 (LFEN-NI.–64-a) ON THE DETERMINATION OF ERRORS OF PHYSICAL MEASUREMENTS. de Lima, Ermelinda Pedroso (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1971. 56p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

In any physical measurement, observation errors occur. These can be divided into systematic errors and aleatory or random errors. The systematic errors are inherent in the measurement system and are constants. The random errors are, however, variables and can be treated by methods from probability theory. The distribution laws governing the spread of the measurement values are derived and confidence errors are determined. The law of the propagation of errors, χ^2 test, and rejection of data are considered. The conclusions are applied to radioactivity measurements. (J.S.R.)

6829 (MNC–3783-10) USE OF POSITION-SENSITIVE SEMICONDUCTOR DETECTORS IN THE STUDY OF HEAVY ELEMENT NUCLEAR REACTIONS. Minor, M. M.; Salwin, A. E.; Viola, V. E. Jr. (Maryland Univ., College Park. Dept. of Chemistry); Theus, R. B.; Bondelid, R. O. (Naval Research Lab., Washington, D. C.). Aug 1971. Contract AT(40-1)-3783. 32p. Dep. NTIS.

The application of position-sensitive semiconductor detectors to the study of heavy element nuclear reactions at intermediate energies is described. Experimental procedures and results are presented for the use of these devices in the following types of measurements: (1) binary fission fragment angular correlations; (2) fission fragment angular distributions; (3) kinetic energy release in fission, and (4) spallation recoil product angular distributions. The position-sensitive detectors are found to provide much improved experimental efficiency over normal semiconductor detectors in experiments where the angular dependence of the products is quite rapid; e.g., fission fragment angular correlations and spallation recoil angular distributions. For experiments in which the product counting rates vary slowly with angle, such as fission fragment angular distributions, the position detector is much less useful. Although the energy resolution of these devices is poorer than normal detectors, they are advantageous in experiments designed to study fission energetics as a function of reaction kinematics. (auth)

6830 (NP–19119) SIMPLE TWO-DETECTOR METHOD FOR PRECISION INTERCOMPARISONS OF SOURCE STRENGTHS. Valkonen, M.; Kantele, J. (Jyvaskyla Univ. (Finland). Dept. of Physics). Jun 1971. 13p. Dep. NTIS (U. S. Sales Only).

A two-detector method for comparing source strengths which largely eliminates errors due to uncertainties of geometric character is described. The simplest version of the method is based on the fact that, when a symmetric face-to-face geometry is being used, the change of the counting rate of one detector caused by the change of the position of the source is approximately compensated for by the change of the counting rate of the other detector. In a more versatile geometry, in which the axes of the detectors are slightly misaligned, the sum and the ratio of the two counting rates can be used in a simple manner to virtually eliminate uncertainties due to the shapes and horizontal positions of point, line and disc sources. (auth) (FINLAND)

6831 (NYO–3246-TA-9) RESEARCH ON AVALANCHE TYPE SEMICONDUCTOR RADIATION DETECTORS. Semiannual Report, January–June 1971. Moldofsky, Philip J.; Hewka, Peter V. (General Electric Co., Philadelphia, Pa. Space Div.). Jul 1971. Contract AT(30-1)-3246. 58p. Dep. NTIS.

The design of an improved three-detector esophageal probe that has been fabricated and performance-tested is described. The detection capabilities of this probe are described in terms of level of sensitivity, angular uniformity of sensitivity, and the Minimum Detectable Amount (MDA) capability for plutonium detection (^{238}Pu and ^{239}Pu) under given assumptions of physiology and test procedure. Also, the first detectors fabricated from specially modified Czochralski-grown silicon are described. Uniformity of resistivity and gain over detectors with surface area of 7 mm^2 was demonstrated by the improved energy resolution. Attempts to incorporate this silicon and Czochralski silicon which operates at higher voltages and gains, grown with a relatively flat liquid-solid interface, into plutonium detector designs are discussed. The silicon uniformity studies are discussed. A fast-electronics signal processing system to follow the avalanche detector has been assembled to take advantage of the fast response time of the detector in the reduction of noise. A significant decrease in system noise is reported with the concurrent increase in detection efficiency permitted by the lower threshold resulting from lower noise. (auth)

6832 (ORNL-TM-3370) RADIOLOGICAL INSTRUMENT DESIGN INVESTIGATION FOR OCD. Annual Report, January 1970–October 1970. De Lorenzo, J. T.; Glass, F. M.; Kennedy, E. J.; Manning, F. W.; Rochelle, J. M.; Wilson, H. N.; Zedler, R. E. (Oak Ridge National Lab., Tenn.). 31 Mar 1971. 49p. Dep. NTIS.

Miniature gas-discharge ionization chamber instruments were studied, and two experimental modules were constructed and tested. Additional observations and data were recorded to determine radiation effects on metal-oxide field-effect transistors. A low-power, solid-state electrometer circuit constructed in module form was investigated, and an experimental instrument was constructed by combining the meter, ionization chamber, and packaging of a model CD V-715 instrument with the electrometer circuit module. It is estimated that this instrument, if engineered for production, could be produced for about $75 each in quantities of 10,000. The production cost of the 1962 model was $25–30. A commercial operational amplifier was studied for application to electrometer type radiological instruments. Also, a study of proportional counters for use in OCD gamma survey meters was started. Utilization of breadboard-type integrated circuits was investigated. (auth)

6833 (ORNL-TM-3598) GAINCALB: A PROGRAM PACKAGE TO DETERMINE THE GAIN USED WITH ORGANIC SCINTILLATION DETECTORS. Zobel, W.; Hall, M. E. Jr. (Oak Ridge National Lab., Tenn.). 13 Oct 1971. 77p. Dep. NTIS.

A package of computer programs, called GAINCALB, has been developed for use on IBM/360 computers. The package is designed to determine the gain employed in neutron spectroscopy experiments using organic scintillation detectors. The package assumes that the gain is determined by an auxiliary experiment using a gamma-ray source, and has been tested specifically with data obtained with a ^{22}Na source. Among input required is a theoretically determined distribution of the energy loss from Compton electrons in the scintillator; however, the calculation of such a distribution is not part of the package. The program is applied to data published by Verbinski et al., which have been used to define a "Light Unit" in connection with an experimental determination of response functions for a 4.60- × 4.65-cm-diam. NE-213 detector, and the result is given. All programs other than those which are available on the ORNL system library or in other packages are listed, and a sample case to illustrate input required and output obtained is shown. (auth)

6834 (RS–21/40) PORTABLE COUNT RATE DOSIMETER OF ^{131}I IN MILK. Gonzalez, A. J.; Haehnel, C. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1970. 25p. (In Spanish). INIS.

A portable count rate dosimeter for use in the case of accidents in a nuclear reactor with the release of ^{131}I to the surroundings is described. The dosimeter was designed to measure the contamination levels in the milk produced in the contaminated zone. (tr-auth)

6835 (UCRL–73239) HIGH-RATE DIRECT-COUPLED PREAMPLIFIER FOR HIGH ENERGY Ge DETECTOR SYSTEMS. McQuaid, James H. (California Univ., Livermore. Lawrence Livermore Lab.). Sep 1971. 16p. (CONF-711111–17). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

The fast counting of high energy gamma events with excellent resolution is made possible by the design of a recycling preamplifier and a direct-coupled spectrometer system. Measurements were performed with a 40 cc Ge(Li) coaxial detector. Data were observed with and without pile-up rejection for count rates up to 150,000 counts/s. Resolution without pile-up rejection for ^{60}Co was 2.50 keV FWHM at 75,000 counts/s (1.5-μs shaping). The exceptional performance of this direct-coupled system is mainly attributed to the preamplifier which requires no pole-zero compensation. After single differentiation the pulses return precisely to the baseline. (auth)

6836 SOME RECENT PROGRESS IN NEUTRON RADIOGRAPHY AND IONIZING PARTICLE DOSIMETRY USING CELLULOSE NITRATE AS RECORDING MATERIAL. Barbier, J. (Kodak-Pathe Research Labs., Vincennes, France). J. Photogr. Sci.; 19: No. 4, 108-12(Jul-Aug 1971).

Improvements in the composition of cellulose nitrate as a detector of alpha particles and certain fission products are presented. Methods of contact printing from the exposed and etched cellulose sheets are described and the use of this new plastic material for neutron radiography and radiation dosimetry is discussed. (auth)

6837 OPERATION OF PROPORTIONAL COUNTERS AT LOW PRESSURES FOR MICRODOSIMETRY. Campion, P. J. (National Physical Lab., Teddington, Eng.). Phys. Med. Biol.; 16: No. 4, 611-16(Oct 1971).

The characteristic peak in the gain versus pressure curve, observed experimentally by some workers using low pressure proportional counters, was shown to be due to the Townsend avalanche extending from anode to cathode. Theoretical curves relating the variation in gain (due to the variation in the position of the initial ionization) with operating pressure indicated that the limiting pressure for a typical Rossi type counter is about 1.5 torr for a gain variation of 10%. A method for reducing this limit by an order of magnitude is suggested. (auth)

6838 QUANTITATIVE PROFILE SCANNING FOR THE MEASUREMENT OF ORGAN RADIOACTIVITY. Tothill, P.; Galt, Jean M. (Univ. of Edinburgh). Phys. Med. Biol.; 16: No. 4, 625-34(Oct 1971).

A profile scanner was constructed, forming part of a whole-body counter, with two detectors placed above and below the patient. Variable width collimators were fitted, and multi-slit focused and limited width collimators were available. The patient lay on a trolley which moved through the well-shielded detector tunnel at variable speeds. The effects of collimator slit width on sensitivity and spatial resolution were studied, as well as methods of compensation for the difference in response due to variations in the depth of a concentration of radioactivity and in the body thickness. By using the geometric mean of opposing counts the counting efficiency was found to be largely independent of source depth and size for a wide range of γ-ray energies. Methods of determining the effective thickness of the body by γ-ray transmission measurements were developed. The techniques were applied to a number of clinical and dosimetry problems, with organ activities in the range 0.1 μCi to 10 mCi. (auth)

6839 TWO-DIMENSIONAL POSITION-SENSITIVE RADIATION DETECTOR. Borkowski, Casimer J.; Kopp, Manfred K. (to United States Atomic Energy Commission). U. S. Patent 3,603,797. 7 Sep 1971. Filed 10 Mar 1970.

A two-dimensional position-sensitive detector has been provided to measure the coordinates of the location and the energy loss of charged particles and ionizing radiation. The device comprises an ordered array of high resistance collector wires strung in parallel. Adjacent wires are interconnected at both ends by a series of resistors to form a four output terminal network. A comparison of the rise times of the output pulses from these four terminals gives the coordinates of an ionizing event within the sensitive area of the detector. The amplitude of the sum of the four output pulses gives the energy loss of the event in the detector gas. (auth)

6840 NEUTRON DOSIMETER INCLUDING A STEP WEDGE FORMED OF AN ALPHA-ATTENUATING MATERIAL. Kastner, Jacob; Oltman, Billie G. (to United States Atomic Energy Commission). U. S. Patent 3,604,931. 14 Sep 1971. Filed 10 Dec 1969.

A neutron dosimeter includes a material which emits alpha particles when bombarded with neutrons, a plastic foil in position to intercept these alpha particles and a step wedge of a material, capable of attenuating the alpha particles disposed between the alpha-emitting material and the plastic foil. The step wedge varies from zero thickness to such a thickness as will attenuate the most energetic alpha particles formed in the dosimeter to particles having an energy such that the particles form tracks in the plastic foil. Following exposure to neutrons the plastic foil is etched to expose the alpha tracks in the plastic. The location of the tracks in the plastic indicates the energy of the neutrons and the total number of tracks in the plastic indicates the intensity of the neutron flux. (auth)

6841 SIMPLIFIED LIQUID SCINTILLATION COUNTING. Barber, D. E. (Univ. of Minnesota, Minneapolis). Phys. Med. Biol.; 16: No. 4, 687-9(Oct 1971).

An arrangement is described for scanning the activity in samples without quenching corrections. A Picker Liquimat Liquid scintillation counter was used, with a secondary sample vial inserted into a liquid scintillation vial containing a standard preparation. Results were calibrated with a 4π gas-flow proportional counter. The solvent was re-usable and the sample not destroyed. Results are shown of detection efficiency versus maximum β-ray energy for the following elements: ^{14}C, ^{59}Fe, ^{131}I, ^{204}Tl, ^{91}Y, ^{32}P, and ^{106}Ru-^{106}Rh. (UK)

6842 STATISTICS OF COINCIDENCE DETECTION EFFICIENCY IN LIQUID SCINTILLATION SPECTROMETRY. Jordan, P. (Eidgenoessische Technische Hochschule, Zurich). Nucl. Instrum. Methods; 97: No. 1, 107-11(1971).

It is pointed out that most treatments on the efficiency of coincidence detection in liquid scintillation counting which appeared in the literature are either ambiguous or erroneous. Correct formulas and numerical values for exact calculations are given. Implications of the statistical nature of particle detection for low energy spectrometry are considered. (auth)

6843 CHERENKOV DETECTORS FOR LOW-ENERGY GAMMA RAYS. Sowerby, B. D. (Australian Atomic Energy Commission, Sutherland). Nucl. Instrum. Methods; 97: No. 1, 145-9(1971).

The use of Cherenkov detectors for discrimination against a high flux of γ rays with energies less than the Cherenkov threshold is described. In measuring the response of Cherenkov detectors to γ rays with energies from 60 keV to 2.6 MeV it was found that the sensitivity of such detectors to γ rays below threshold was greatly reduced by using quartz-window photomultiplier tubes. The possible application of Cherenkov detectors to borehole analysis has been investigated. (auth)

6844 DETERMINATION OF GAMMA RAY ENERGY THROUGH MEASUREMENT OF THE OPENING ANGLES OF THE MATERILISATION PAIRS CREATED IN A SPARK CHAMBER. APPLICATION TO THE SPECTRUM OF THE ATMOSPHERIC GAMMA RAYS. Claverie, A.; Niel, M.; Vedrenne, G. (Univ., Toulouse. Centre d'Etude Spatiale des Rayonnements, Toulouse). Nucl. Instrum. Methods; 97: No. 1, 161-9(1971).

A multiplate spark chamber with photographic readout and coincidence scintillation and Cherenkov detectors for triggering the spark chamber and for background elimination is described for measuring photon energies. The photon energy is estimated by measuring the electron—positron opening angle in pair production. Calculations are presented for correcting the opening angle for multiple scattering. (W.H.K.)

6845 LINEARITY AND NOISE CONSIDERATIONS FOR POSITION SENSITIVE DETECTORS. Mathieson, E. (Univ. of Leicester, Eng.). Nucl. Instrum. Methods; 97: No. 1, 171-6 (1971).

A theoretical examination has been made of a position sensitive detector system in which positional information is obtained from the cross-over time of the output signal from a doubly differentiating, singly integrating circuit. Parameters describing the nonlinearity and the positional resolution due to noise have been evaluated numerically; a preferred range of circuit time constants has been found. (auth)

6846 MULTI-WIRE PROPORTIONAL CHAMBERS WITH UNIFORM GAIN. Parker, S. (Univ. of California, Berkeley); Jones, R.; Kadyk, J.; (and others). Nucl. Instrum. Methods; 97: No. 1, 181-5(1971).

A method is described for constructing and operating multi-wire proportional chambers having systematic gain variations of less than ±2% rms over their entire active area. (auth)

6847 MULTIWIRE PROPORTIONAL CHAMBERS USED IN ANALOGUE MODE FOR BEAM PROFILE AND FLUX MEASUREMENTS. Lehraus, I.; Matthewson, R. (CERN, Geneva). Nucl. Instrum. Methods; 97: No. 1, 187-94(1971).

A description of a system of multiwire proportional chambers employed as hodoscopes in secondary proton synchrotron beams using fast ejection is given. Each chamber has 64 channels spaced by 1 mm, has a spatial resolution of 2 mm (fwhm) and a wire to wire uniformity better than ±5%. The system operates at a signal level of 4 mV per relativistic particle and has a dynamic range of 256 : 1. (auth)

6848 PULSE SHAPE AND THE TIMING PROBLEM IN SOLID STATE DETECTORS: A REVIEW PAPER. Alberigi Quaranta, A. (Univ., Modena, Italy); Martini, M.; Ottaviani, G. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 2, 35-61(Apr 1969).

A survey is presented of the theoretical and experimental data obtained in the last eight years about both the shape of the pulses supplied by semiconductor detectors and the techniques for obtaining from these pulses a fast timing information. Moreover the problem is considered of extracting from the shape of the pulse some information on the type or the impact angle of the detected radiation. (63 references). (auth)

6849 EFFECTS OF LONG TERM STORAGE ON LITHIUM DRIFTED SILICON DETECTORS. Hubbard, E. L. (Philco-Ford Corp., Palo Alto, Calif.); Kramer, B. R. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 4, 16-19 (Aug 1969).

The characteristics of four lithium drifted silicon surface barrier detectors have been studied. Detector noise and leakage current were measured at the beginning and end of a sixteen month interval. The thickness of the intrinsic region, at the beginning and end of a fourteen month interval, was determined by use of proton beams from the University of Southern California Linac and the University of Colorado cyclotron. Detector noise measurements were made using both a standard pulser technique and the photopeak from ^{133}Ba. The noise and leakage were measured at −54°C, +20°C and +60°C. The detector leakage was measured as a function of bias at +20°C. The detector thickness measurements were also performed at +20°C. (auth)

6850 X-RAY AND GAMMA INTENSITY MEASUREMENT. Cabe, Leslie E. (Western Electric Co., Whippany, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 4, 29-30(Aug 1969).

A method for developing a graph of radiation intensity vs. time for a pulse of x-ray or gamma radiation is presented. The method has been used for determining radiation intensities from pulses of nanoseconds duration with intensities in the 10^{10} to 10^{11} roentgens/sec range. It is applicable to pulses of different durations and intensities. (auth)

6851 PERFORMANCE OF LARGE PLASTIC SCINTILLATION COUNTERS AS PROTON SPECTROMETERS. Gottschalk, B. (Northeastern Univ., Boston); Kannenberg, S. L. Nucl. Instrum. Methods; 97: No. 2, 291-8(1971).

The construction of a large Pilot Y scintillation counter designed to measure proton energies to 215 MeV is described, and results of tests on five identical units using a well-collimated monochromatic 160 MeV proton beam are presented. Light output is a relatively smooth function of distance from the photomultipliers, and can be fit to about 1% by a one-dimensional quadratic polynomial. The full-width at half-maximum (fwhm) line width for protons stopping by multiple Coulomb interactions is typically 1.8% and is shown to be due to photoelectron statistics. The energy calibration above 50 MeV can be represented by a linear function with non-zero intercept. (auth)

6852 MEASUREMENT OF SYSTEM DEAD TIME WITH COMMERCIALLY AVAILABLE NIM MODULES. Nelson Nelson, C. B.; Hardin, J. M.; Coats, G. I. (Northeastern Radiological Health Lab., Winchester, Mass.). Nucl. Instrum. Methods; 97: No. 2, 309-13(1971).

A procedure to measure the dead time of a counting system with a commercially available NIM type gate and delay generator and a gated scaler is described. A gate method was used to determine the dead time of a 4π proportional counter to within 0.1 μsec as a routine part of the counting procedure; agreement was found when comparison was made with the two source method. (auth)

6853 ANGULAR DISTRIBUTION OF TRAPPED LIGHT IN RECTANGULAR SCINTILLATION COUNTERS. Smith, T. (Univ. Coll. Hospital Medical School, London). Nucl. Instrum. Methods; 97: No. 2, 409-11(1971).

An equation is derived which can be used to determine the distribution in solid angle of "trapped" light in rectangular scintillation counters, for purposes of calculating attenuation factors for this proportion of scintillation light. The use of the equation is illustrated for three systems in which the critical angle for total internal reflection is less than, equal to and greater than $\pi/4$. The value of the equation as an aid to the design of large rectangular scintillation counters is discussed. (auth)

6854 CHANNEL ELECTRON MULTIPLIER EFFICIENCY FOR 10 TO 1000 eV ELECTRONS. Bordoni, F. (Univ. of Rome). Nucl. Instrum. Methods; 97: No. 2, 405-8(1971).

The relative efficiency versus energy of a type 4028 Bendix Channeltron has been measured for electron energies in the range 10 to 1000 eV. A theoretical curve derived from Lye and Dekker's theory of the secondary emission permits the derivation of the absolute values of the efficiency from the experimental data. Moreover the dependency of the efficiency on the operating voltage has been investigated and the experimental results are in agreement with the theoretical previsions. (auth)

6855 RESPONSE FUNCTION OF SEMICONDUCTOR PROTON RECOIL COUNTERS WITH AXIAL SYMMETRY TO PARALLEL NEUTRON BEAM. Gotoh, H.; Yagi, H. (Japan Atomic Energy Research Inst., Tokai-mura). Nucl. Instrum. Methods; 97: No. 2, 419-21(1971).

The response function of semiconductor proton recoil counters with axial symmetry to a parallel neutron beam is represented by elementary functions containing inverse trigonometric functions. (auth)

6856 USE OF TUNGSTEN AS A THERMAL NEUTRON FLUX MONITOR AT VERY HIGH TEMPERATURE. Nir-el, Y.; Venezia, A. (Soreq Nuclear Research Centre, Yavne, Israel). Nucl. Instrum. Methods; 97: No. 2, 423-4(1971).

The feasibility of using tungsten as a thermal neutron flux monitor at very high temperatures was studied experimentally. The flux was calculated from the absolute activity of ^{187}W measured with a calibrated Ge(Li) detector. Good results were obtained at temperatures in the vicinity of 2000°C. (auth)

6857 VERSATILE GAMMA-RAY CAMERA FOR DYNAMIC OR STATIC STUDIES IN MEDICINE. Moody, N. F.; Paul, W.; Joy, M. (Univ. of Toronto). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 2, 3-18(Apr 1969).

The design of a medical γ ray camera for use in the isotope energy range 150 to 400 keV is described. It is based on the use of image-intensifiers, yields 1000 picture element definitions, and provides discrimination against Compton scatter and other spurious signals. The present camera will accept 30,000 photopeak events/sec, but this is not an ultimate limit. Thus the instrument is well suited to both static and dynamic studies. (auth)

6858 NEW METHOD FOR CALIBRATING LOW INTENSITY NEUTRON SOURCES. Kedem, Dan; Kedem, Drora (Soreq Nuclear Research Centre, Yavne, Israel). Nucl. Instrum. Methods; 97: No. 2, 267-73(1971).

An easy and rapid method is described for calibrating small neutron sources by comparing them with a known standard source of similar energy spectrum. The described scintillation detector in a polyethylene moderator can also be used for neutron monitoring. (auth)

6859 NEW DETECTOR FOR TRUE MULTIPLANE SCANNING AND MEASUREMENT OF ABSOLUTE LOCAL ACTIVITY. Petit-Clerc, Y. (Univ. of Sherbrooke, Quebec, Canada). Nucl. Instrum. Methods; 97: No. 2, 337-42(1971).

A new detector with equal lateral and depth resolution has been devised to study radioisotope distributions in the human body. Calculations and experimental verification of the detection profile are presented. The detection volume is a sphere, ½ inch in radius, at 50% detection efficiency relative to the center. The response drops to zero at one inch from the center and thus permits measurement of local activity even in the presence of a uniform radioactive distribution around the object of interest. The technique is especially valuable for brain and thyroid gland scanning. (auth)

6860 LIQUID ARGON IONIZATION CHAMBER AS A COUNTER FOR α-PARTICLES. Deshpande, R. Y.; Pardhasaradhi, S. K.; Ramanna, R. (Bhabha Atomic Research Centre, Bombay). pp 519-26 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol. 2).

6861 USE OF LIQUID CRYSTALS AS MEDIA FOR CONTINUOUSLY SENSITIVE CHAMBERS FOR THE REGISTRATION OF ELEMENTARY PARTICLES. Jalaluddin, A. K.; Husain, Hashmat (Aligarh Muslim Univ., India). pp 527-32 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

6862 MEASUREMENT OF LOW REACTION CROSS-SECTIONS WITH DIELECTRIC TRACK DETECTORS. Srivastava, D. S. (Aligarh Muslim Univ., India); Somogyi, G.; Schlenk, B.; Hunyadi, I. pp 533-8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

6863 MODIFICATION OF THE RESPONSE OF A SEMICONDUCTOR DOSIMETER. Bevan, J. S.; Christodoulides, G. (Polytechnic of the South Bank, London). Health Phys.; 21: No. 6, 853-7(Dec 1971).

A range of simple filters was made that flattened the response function of cylindrical silicon semiconductor probes in trial use as intrarectal dosimeters. Results are presented for the effects of lead and depleted uranium filters on a series of 6 mm detectors using ^{137}Cs and ^{60}Co sources, and a specially filtered and calibrated x ray machine for low energy points. Experiments were carried out at room temperatures over a keV range 0 to 1000. (UK)

6864 RECORDING OF FAST NEUTRONS WITH NUCLEAR PHOTOEMULSIONS. Anashkina, E. S. Geofiz. App.; No. 44, 168-70(1970). (In Russian).

The determination of 0.5 to 14.0 MeV neutrons employs proton recoil from the hydrogen in an emulsion. The emulsion may be deposited on a thin glass film for convenient dosimetry. P. Rosen's nuclear emulsion technique was found to have an error of not less than 2.5% for 10 to 14 MeV neutrons, and 6% for 1 to 2 MeV neutrons. (K.S.W.)

6865 DESIGN OF A VERSATILE SURVEYMETER. Chiang, Hai Hung; Chang, Jinnu Kwang (National Tsing Hua Univ., Taiwan). Nucl. Sci. J. (Taiwan); 8: No. 1, 60-8(Apr 1971).

A model of a portable ion-chamber type radiation detecting instrument which is primarily used for measuring beta, gamma or x-radiation up to 2000 milliroentgens per hour is described. The survey meter contains an airfilled chamber, a direct-coupled amplifier, and a battery power supply. The chamber is made of a plastic material in cylindrical shape, with a polyester film as its end-window. The collector is supported by a polished Teflon insulator. The amplifier consists of two stages, connected as a feedback loop. Either an electrometer tube or a field-effect transistor may be employed as the first stage, and the second stage is a complementary transistor pair. This circuit is stable and sensitive enough in cooperation with the chamber; the accuracy is about ±10% at full scale. The instrument can be satisfactorily operated in the temperature range of 4° to 32°C with humidity up to 90 percent. The battery life is longer than four weeks for continuous operation, and the price for one set of parts and materials is about $45. (auth)

6866 FABRICATION OF COAXIAL LITHIUM-DRIFTED GERMANIUM DETECTORS. Jao, Sung-shan; Chang, Hai-hsin (Inst. of Nuclear Research, Lungtan, Taiwan). Nucl. Sci. J. (Taiwan); 8: No. 1, 48-59(Apr 1971).

Two open-ended coaxial lithium-drifted germanium detectors of about 12 cm^3 volume have been fabricated from pulled, gallium doped, p-type germanium single crystal oriented in a $\langle 111 \rangle$ direction. Resolutions of 2.7 to 3 keV (FWHM) for gamma rays from ^{60}Co have been obtained with a conventional low-noise (FET) preamplifier. The fabrication techniques are described in detail. The fabricated detectors were left at room temperature for 25 to 30 hours by accident and were restored to the original performance by a clean-up process that consisted of applying a bias up to 500 volts to the detector at about −10°C to give a leakage current below 30 mA. (auth)

6867 EXTERNAL DIAMETERS OF CYLINDRICAL RADIATION PROBES CONTAINING GEIGER–MUELLER OR PROPORTIONAL COUNTER TUBES OR SCINTILLATION DETECTORS. IEC Publication 256 1967. Geneva; Bureau Central de la Commission Electrotechnique Internationale (1967). 5p. (In French and English). Available from American National Standards Institute, New York.

An IEC recommendation that specifies the external diameters of cylindrical radiation probes containing G–M counters, proportional counters, or a scintillation counter, and possibly a preamplifier is presented. (W.H.K.)

6868 NEUTRON MEASUREMENT UNIT WITH A WIDE DYNAMIC RANGE. PULSE-FLUCTUATION COMBINATION. Plaige, Y. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Instrum. Nucl.; No. 43, 26-30(Mar 1971). (In French).

Pulse instrumentation is widely used in reactor control. Fluctuation type instrumentation is being developed industrially and will be used in the near future. Fission chambers are used as detectors in both types of instrumentation. An instrument with a wide dynamic range involving both these basic techniques was studied. The theoretical analysis of the problem, the preliminary practical applications, and the results of in-pile tests in Isis are presented. It is concluded that a control instrumentation operating over a dynamic range of ten decades will probably be developed shortly. (France)

6869 DETECTION OF THE PLANE OF POLARIZATION OF 121 keV LINEARLY POLARIZED PHOTONS. Logan, B. A. (Univ. of Ottawa). Can. J. Phys.; 49: No. 20, 2612-14(15 Oct 1971).

The polarization sensitivity of a 3 mm × 8 mm × 25 mm Si(Li) detector was investigated with linearly polarized 121 keV photons. The results indicate that such detectors can serve a useful role in nuclear spectroscopy. (auth) (Canada)

6870 SPARK CONTROL DEVICE FOR SPARK CHAMBERS. Lansiard, Alain; Leloup, Jean; Morucci, Jean-Pierre; Roux, Georges (to Commissariat a l'Energie Atomique). British Patent 1,252,364. 3 Nov 1971. Priority date 26 Feb 1968, France.

A discharge control device for a three-electrode spark chamber is described. The discharge control includes a short circuit device comprising an avalanche connected transistor stage, a first power stage (triode), and a second power stage (tetrode) in which the anode–cathode space is connected in parallel with the grid–anode space of the chamber. (W.H.K.)

6871 ALPHA PARTICLE IMAGING WITH A SILICON DIODE ARRAY VIDICON TUBE. Harpster, Joseph William. Columbus, Ohio; Ohio State Univ. (1971). 90p. University Microfilms Order No. 71-27,480.

Thesis.

Silicon p-n junction arrays have been successfully employed as the target element in a standard TV camera vidicon tube for the purpose of α radiation imaging. Special targets were constructed having a thickness nearly equal to the α particle range in silicon. A detailed description of the method of target construction and image tube assembly is given. Targets were constructed from 5 to 17 ohm-cm, n-type silicon. The diode density was 2.5×10^5 per square inch and the target thickness was 25 μm. Vacuum was required on both sides of the target since the target was not self-supporting. The radiation source used for the image work was 1 μC of ^{241}Am. A radiograph of a wing and leg of a house fly was obtained by taking a photographic time exposure of the TV monitor. Measurement of line resolution was equivalent to the width of two diodes and their separation distance or 75 μm. This is as expected if on the average four nearest neighbor diodes collect charge from an α particle interaction by minority carrier diffusion. A theoretical discussion of minority carrier diffusion from an α particle ionization track in the zero field base region of the target is given with the obtained results in agreement with experimental findings. It is shown that recombination of hole-electron pairs in the initial 10^{18} carriers/cm^3 ionization track is not excessive and can be neglected. A discussion is given for target response to α particles from other sources. In particular, α particles originating in a ^{6}Li neutron converter layer is analyzed in detail. Conversion efficiencies and design criteria are given for a new, useful and low cost neutron image tube. (Diss. Abstr. Int., B)

6872 ROLE OF SEMICONDUCTOR DETECTORS IN THE FUTURE OF NUCLEAR MEDICINE. Proceedings of a Symposium, Chicago, Illinois, February 12–13, 1971. Hoffer, Paul B.; Beck, Robert N.; Gottschalk, Alexander (eds.). New York; Society of Nuclear Medicine, Inc. (1971). 317p. $7.50. (CONF-710204).

Separate abstracts were prepared for 16 of the 20 papers presented. The remaining 4 papers were previously included in NSA. (W.H.K.)

For abstracts of individual papers see: 6873–6886, 6904, and 7064.

6873 SEMICONDUCTOR RADIATION DETECTORS. Goulding, Fred; Stone, Yvonne (Univ. of California, Berkeley). pp 1-15 of Role of Semiconductor Detectors in the Future of Nuclear Medicine. /Hoffer, Paul B. (ed.). New York; Society of Nuclear Medicine, Inc. (1971).

From Symposium on the role of semiconductor detectors in the future of nuclear medicine; Chicago, Ill. (12 Feb 1971).

The fundamental theory of semiconductor detectors is discussed including the charge-production process, the charge-collection process, and detector materials. The use of semiconductor spectrometers in x-ray fluorescence analysis and activation analysis is briefly described. (W.H.K.)

6874 FUNDAMENTALS OF SEMICONDUCTOR DETECTOR SYSTEMS DESIGN. Bradley, A. E. (Univ. of California, Livermore). pp 37-51 of Role of Semiconductor Detectors in the Future of Nuclear Medicine. /Hoffer, Paul B. (ed.). New York; Society of Nuclear Medicine, Inc. (1971).

From Symposium on the role of semiconductor detectors in the future of nuclear medicine; Chicago, Ill. (12 Feb 1971).

An elementary introduction to some of the design fundamentals of semiconductor detectors is presented. (W.H.K.)

6875 PRACTICAL PROBLEMS IN SYSTEMS DESIGN. Orth, John (Nuclear Diodes, Inc., Prairie View, Ill.). pp 52-7 of Role of Semiconductor Detectors in the Future of Nuclear Medicine. /Hoffer, Paul B. (ed.). New York; Society of Nuclear Medicine, Inc. (1971).

From Symposium on the role of semiconductor detectors in the future of nuclear medicine; Chicago, Ill. (12 Feb 1971).

Four problem areas in the design of semiconductor detector systems for medical applications are discussed. These problems include cryogenic cooling of the detector and preamplifier, microphonics associated with the cryogenic electronic system, detector material and size, and electronic circuit compatability of semiconductor systems with existing instruments. (W.H.K.)

6876 NEWER DEVELOPMENTS IN DETECTOR DESIGN AND MATERIALS. Palms, John M. (Emory Univ., Atlanta). pp 58-78 of Role of Semiconductor Detectors in the Future of Nuclear Medicine. /Hoffer, Paul B. (ed.). New York; Society of Nuclear Medicine, Inc. (1971).

From Symposium on the role of semiconductor detectors in the future of nuclear medicine; Chicago, Ill. (12 Feb 1971).

Recent advances in the development of semiconductor materials for radiation detectors are reviewed. Essential material characteristics are discussed, and recent progress in detector material technology including germanium, cadmium telluride, and gallium arsenide are reviewed. Also, nuclear medicine detectors are considered including implantable brain probe, brain-tumor probe, and the esophageal probe. (49 references). (W.H.K.)

6877 AVALANCHE SEMICONDUCTOR DETECTORS IN BIOLOGY AND MEDICINE. Huth, Gerald C.; Moldofsky, Philip J. (General Electric Co., Philadelphia). pp 79-89 of Role of Semiconductor Detectors in the Future of Nuclear Medicine. /Hoffer, Paul B. (ed.). New York; Society of Nuclear Medicine, Inc. (1971).

From Symposium on the role of semiconductor detectors in the future of nuclear medicine; Chicago, Ill. (12 Feb 1971).

The operation of avalanche detectors and their development for use in nuclear medicine for low-energy x-ray detection and for beta detection are discussed. (W.H.K.)

6878 THEORETICAL ADVANTAGES OF ELIMINATING SCATTER IN IMAGING SYSTEMS. Beck, R. N.; Zimmer, L. T.; Charleston, D. B.; Hoffer, P. B.; Lembares, N. (Univ. of Chicago). pp 92-113 of Role of Semiconductor Detectors in the Future of Nuclear Medicine. /Hoffer, Paul B. (ed.). New York; Society of Nuclear Medicine, Inc. (1971).

From Symposium on the role of semiconductor detectors in the future of nuclear medicine; Chicago, Ill. (12 Feb 1971).

The problem of gamma scattering in radioisotope scanners and other imaging systems is studied. The modulation transfer function is used to measure the spatial resolution; and the figure of merit, which is a function of sensitivity and spatial resolution, provides a criterion for optimizing the base-line setting and comparing detectors. (W.H.K.)

6879 EFFECT OF MINIMIZING SCATTER USING Ge(Li) DETECTORS ON PHANTOM MODELS AND PATIENTS. Hoffer, Paul B.; Beck, Robert N. (Univ. of Chicago). pp 131-43 of Role of Semiconductor Detectors in the Future of Nuclear Medicine. /Hoffer, Paul B. (ed.). New York; Society of Nuclear Medicine, Inc. (1971).

From Symposium on the role of semiconductor detectors in the future of nuclear medicine; Chicago, Ill. (12 Feb 1971).

Preliminary studies on the effect of scatter rejection on scans produced with low-energy monochromatic photon emitters, the effect of scatter rejection on the use of polychromatic gamma emitters, and the effects of scatter rejection and photopeak isolation on duel-isotope scanning systems are described. (W.H.K.)

6880 CATHETER SEMICONDUCTOR DETECTOR AND ITS APPLICATION TO CLINICAL AND EXPERIMENTAL MEDICINE. Sasaki, Yasuhito (Johns Hopkins Medical Institutions, Baltimore); Wagner, Henry N. Jr.; Iio, Masahiro; (and others). pp 144-56 of Role of Semiconductor Detectors in the Future of Nuclear Medicine. /Hoffer, Paul B. (ed.). New York; Society of Nuclear Medicine, Inc. (1971).

From Symposium on the role of semiconductor detectors in the future of nuclear medicine; Chicago, Ill. (12 Feb 1971).

A catheter semiconductor radiation detector (CASRAD) small enough to be inserted intravenously is described. CASRAD employs a silicon p–n junction diode, 2.3 mm in diameter and 1 mm long. The performance characteristics and applications of the detector are described. (W.H.K.)

6881 CLINICAL TESTS WITH A PROTOTYPE SEMICONDUCTOR GAMMA CAMERA. McCready, V. R. (Royal Marsden Hospital, Sutton, Eng. Inst. of Cancer Research, Sutton, Eng.); Parker, R. P.; Gunnersen, E. M.; (and others). pp 157-64 of Role of Semiconductor Detectors in the Future of Nuclear Medicine. /Hoffer, Paul B. (ed.). New York; Society of Nuclear Medicine, Inc. (1971).

From Symposium on the role of semiconductor detectors in the future of nuclear medicine; Chicago, Ill. (12 Feb 1971).

Preliminary results in the development of a Ge(Li) gamma camera are presented. The system is based on the orthogonal strip principle using a p–i–n structure. Results indicate the Ge(Li) gamma camera has superior spatial resolution but less sensitivity than conventional scintillation cameras. (W.H.K.)

6882 SEMICONDUCTOR DETECTORS FOR EYE-TUMOR DIAGNOSIS. Larose, James H. (Emory Univ., Atlanta). pp

190-205 of Role of Semiconductor Detectors in the Future of Nuclear Medicine. /Hoffer, Paul B. (ed.). New York; Society of Nuclear Medicine, Inc. (1971).

From Symposium on the role of semiconductor detectors in the future of nuclear medicine; Chicago, Ill. (12 Feb 1971).

The development of surface-barrier, lithium-drifted, and avalanche silicon detectors for ^{32}P eye-tumor diagnosis is discussed. (W.H.K.)

6883 SEMICONDUCTOR DETECTORS FOR RADIOISOTOPE IMAGING AND COUNTING. pp 206-12 of Role of Semiconductor Detectors in the Future of Nuclear Medicine. /Hoffer, Paul B. (ed.). New York; Society of Nuclear Medicine, Inc. (1971).

From Symposium on the role of semiconductor detectors in the future of nuclear medicine; Chicago, Ill. (12 Feb 1971).

A panal discussion on the advantages and disadvantages of semiconductor detectors for radioisotope imaging and counting is given. (W.H.K.)

6884 CLINICAL RESULTS IN FLUORESCENT THYROID SCANNING. Hoffer, Paul B.; Bernstein, Joel; Gottschalk, Alexander (Univ. of Chicago). pp 230-9 of Role of Semiconductor Detectors in the Future of Nuclear Medicine. /Hoffer, Paul B. (ed.). New York; Society of Nuclear Medicine, Inc. (1971).

From Symposium on the role of semiconductor detectors in the future of nuclear medicine; Chicago, Ill. (12 Feb 1971).

The recent development of the fluorescent thyroid scanner is described, and clinical results are presented and discussed. The scanner utilizes a 3.3 Ci^{241}Am source and a 200 mm^2 Si(Li) detector. (W.H.K.)

6885 IN VIVO MEASURE OF REGIONAL CEREBRAL BLOOD FLOW AND BLOOD VOLUME BY MEANS OF STIMULATED X-RAY FLUORESCENCE. PART B. INSTRUMENTATION. Phelps, Michael E.; Ter-Pogossian, Michel M.; Hecht, J. (Mallinckrodt Inst. of Radiology, St. Louis). pp 248-57 of Role of Semiconductor Detectors in the Future of Nuclear Medicine. /Hoffer, Paul B. (ed.). New York; Society of Nuclear Medicine, Inc. (1971).

From Symposium on the role of semiconductor detectors in the future of nuclear medicine; Chicago, Ill. (12 Feb 1971).

The x-ray source, collimated Si(Li) detector, and electronics for x-ray fluorescence measurement of regional cerebral blood flow and blood volume are described. (W.H.K.)

6886 CLINICAL PERSPECTIVE ON SEMICONDUCTOR DETECTORS. pp 271-84 of Role of Semiconductor Detectors in the Future of Nuclear Medicine. /Hoffer, Paul B. (ed.). New York; Society of Nuclear Medicine, Inc. (1971).

From Symposium on the role of semiconductor detectors in the future of nuclear medicine; Chicago, Ill. (12 Feb 1971).

A panel discussion on the problem areas and the possibilities of the use of semiconductor detectors in nuclear medicine is presented. (W.H.K.)

6887 INDEX OF ELECTRICAL MEASURING APPARATUS USED IN CONNECTION WITH IONIZING RADIATION. IEC Publication 181 1964. Geneva; Bureau Central de la Commission Electrotechnique Internationale (1964). 62p. (In French and English). Available from American National Standards Institute, New York.

An index of radiation measuring instruments currently manufactured by industry or likely to be manufactured in the near future, which gives each instrument a designation and a definition to permit its unambiguous identification, is presented. Categories include basic radiation measuring apparatus; special apparatus for the control and the safety of nuclear reactors; special apparatus for health physics; special apparatus for prospecting and for the mining industry; and radiometric gages. (W.H.K.)

6888 CALCULATION OF THE RESPONSE OF SCINTILLATION DETECTORS TO FAST NEUTRONS. Haussen, Waldemar (Paedagogische Hochschule, Erfurt, Ger.); Schweitzer, Thomas; Seeliger, Dieter; Seidel, Klaus. Wiss. Z. Tech. Univ. Dresden; 19: No. 4, 961-4(1970). (In German).

The calculation of the response of a liquid-scintillator neutron detector in the energy range from 0 to 15 MeV, taking into account single and double scattering of neutrons by hydrogen is described. A correction procedure is described which takes into account double scattering by carbon and hydrogen, as well as the effect of nuclear reactions involving carbon on the detector response. (IAA)

6889 INDICATOR PARTICULARLY FOR RADIATION MEASUREMENT. Schneider, Reinhard. German Patent 1,498,222. 4 Sep 1969. Filed 26 Jul 1962. (In German).

An indicator for measurement values particularly in the measurement of radiation is described. The indicator is connected with a meter in the same casing. The measurement range is indicated on an interchangeable scale so that it has coupling and the indicator disc appears according to the partial scale. (tr-auth)

6890 INDEX OF ELECTRICAL MEASURING APPARATUS USED IN CONNECTION WITH IONIZING RADIATION. IEC Publication 181A 1965. Geneva; Bureau Central de la Commission Electrotechnique Internationale (1965). 75p. (In several languages). Available from American National Standards Institute, New York.

A supplement to IEC Publication 181 which was issued in 1964 and which gives designations and definitions, in French and English only, of electrical measuring apparatus used in connection with ionizing radiation, is presented. This supplement groups the designations in nine languages including French, English, Russian, Dutch, German, Italian, Polish, Spanish, and Swedish. (W.H.K.)

6891 INDEX OF ELECTRICAL MEASURING APPARATUS USED IN CONNECTION WITH IONIZING RADIATION. IEC Publication 181B 1966. Geneva; Bureau Central de la Commission Electrotechnique Internationale (1966). 74p. (In several languages). Available from American National Standards Institute, New York.

A supplement to IEC Recommendation 181 which designates and defines radiation measuring instruments is presented. (W.H.K.)

6892 GEOMETRICAL FACTOR FOR COLLIMATED DETECTORS. Iglesias, G. E.; Ortiz de Adler, N. (Univ. Nacional, Tucuman, Argentina). pp 329-43 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. II. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.2).

An attempt was made to solve some of the problems concerning the evident lack of the uniformity in the criteria for calculating the geometrical factors in balloon and rocket-borne detectors. The geometrical factors for circular flat detectors, collimated with circular diaphragms, have been calculated for isotropic and plane isotropic fluxes. Being $\bar{r}$ the radius of the collimator and $\bar{h}$ the distance from the detector to the collimator itself, in units of the collimator radii, the results obtained show that the geometrical factors can be calculated for $\bar{r}$ greater than 3 with an error smaller than 3%, for isotropic flux and plane isotropic flux. Expressions are given. For values of $\bar{r} < 3$, curves of geometrical factors as a function of $\bar{h}$ using $\bar{r}$ as a parameter, are given. The geometrical factor for uncollimated detectors, considering shielding attenuation, has also been calculated for isotropic flux. (auth) (IAA)

Nuclear Spectroscopic Instrumentation

6893 (CEA-CONF-1795) INVESTIGATION OF GAMMA-RAY ENERGIES OF FISSION PRODUCTS WITH A Ge(Li) DETECTOR. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 9 Jun 1971. 20p. (In French). (CONF-710525-1). Dep. NTIS (U. S. Sales Only).

From Conference of the French Society of Electricans and Radio Electricans; Malakoff, France (19 May 1971).

A Ge(Li) semiconductor detector was used to determine the characteristics, energies, and abundances of the γ radiation emitted by U fission products. A detector with high resolution power permits an identification of the fission products according to their energies, but when these energies are poorly known it is necessary to measure and use other characteristics such as radioactive half-life, γ abundances, etc. in order to identify these elements. The quantity of each fission product depends on the transport conditions, particularly the in-pile passage time, time of transit between reactor and trap, and decay time. The OSIRIS loop should permit the realization of conditions such that certain fission products, those relatively abundant, are then easily identified. The spectrometry chain was controlled so as to obtain very precise measurements. The linearity and the stability were examined particularly. A calibration method using only one 511-keV standard was used. The calibration in energy and efficiency was made with FORTRAN programs. The results were processed on the computer at two times: analysis of an experimental spectrum and then identification by comparison with a calculated spectrum. With a resolution of 3 keV in the vicinity of 1 MeV it is possible to obtain certain energies with a precision better than 2×10^{-4}. (tr-auth)

6894 (CEA-N-1494) SPECTRAL UNFOLDING, ALGORITHM FOR SOLVING A FREDHOLM EQUATION OF THE FIRST KIND. Franenberg, H. (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). May 1971. 102p. (In French). Dep. NTIS (U. S. Sales Only).

A process for spectral unfolding is studied. The solution of a Fredholm equation of the first kind was required. Different methods were used to obtain an optimized algorithm which could be used with a Fortran program for processing gamma ray spectra. The programs and instructions for using them are given. (France)

6895 (JAERI–1216) BOB 70: THE PROGRAMME CODE FOR ANALYSIS OF THE GAMMA-RAY SPECTRUM FROM THE Ge(Li) DETECTOR. Baba, Sumiko; Baba, Hiroshi; Okashita, Hiroshi (Japan Atomic Energy Research Inst., Tokyo). 1 Apr 1971. 15p. (In Japanese and English). Dep. NTIS (U. S. Sales Only).

A data-analyzing code developed for spectra with high resolution, such as spectra from the Ge(Li) detector is presented. This code is built for FACOM 230-60 and is adjustable to medium-sized electronic computers. It covers the following functions; (1) data smoothing, (2) peak searching by means of the first derivative method, (3) conversion from the clock-time mode to the live-time mode, and (4) determination of the photopeak energy and intensity. For the analysis of a 2047-channel spectrum, the required memory size is 29 K and the required time is at most 10 seconds as the CPU occupying time. Furthermore, a data-plotting subroutine is available, though fairly inefficient, which is built for the CALCOMP graphic plotter. In the case where data plotting with this subroutine is added, the code requires the additional 5 K memory core and the additional 15-second CPU time. (auth)

6896 (NP–19115) RESPONSE FUNCTION OF A GOOD GEOMETRY DETECTOR FOR NUCLEAR GAMMA CASCADES. Rudstam, Goesta (Forskningsradens Laboratorium, Studsvik (Sweden)). 1971. 24p. (LF–35). Dep. NTIS (U. S. Sales Only).

Response matrices have been calculated based on a statistical model for the development of the gamma cascade from excited nuclear levels. The results are not strongly dependent on the assumptions concerning the gamma emission probabilities or the level density, nor do they depend strongly on the actual nucleus under consideration. It is sufficient to limit the calculations to one average nucleus of each type (odd, odd)mass, even) in each mass region of interest (size 10 to 20 mass units). (auth) (Sweden)

6897 (UCRL–73241) HIGH-RATE SPECTROSCOPY SYSTEM FOR USE WITH Ge(Li) COAXIAL DETECTORS. Dunn, D. R.; Kaifer, R. C.; McQuaid, J. H. (California Univ., Livermore. Lawrence Livermore Lab.). Jun 1971. 16p. (CONF-711111-16). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

A high-rate gamma-ray spectroscopy system with a 40 cc Ge(Li) coaxial detector is described which utilizes a direct-coupled recycling preamplifier, a unipolar Gaussian filter amplifier with only one differentiating network, and a pileup rejector and baseline inspection circuit, to yield excellent resolution. A family of resolution curves is shown as a function of the input count rate (from 50K cps to 175K cps) and of the actual data acceptance rate. For an input rate of 100 kHz and an acceptance rate of 5.5 kHz the FWHM and FW1/10M for the 1.33-MeV peak of ^{60}Co was 2.2 keV and 4.24 keV, respectively. The system lends itself to high counting rates by eliminating the need for pole-zero compensation and baseline restoration. (auth)

6898 STUDY OF A HYBRID SUM-COINCIDENCE SPECTROMETER. Forest, H. (Univ., Nice). Nucl. Instrum. Methods; 97: No. 1, 113-21(1971). (In French).

A versatile sum-coincidence γ-spectrometer is studied. The use of Ge(Li)–NaI(Tl) detectors for measurements allows good resolution with acceptable efficiency. No confusion is possible between real and false cascades. An arrangement with a well NaI(Tl) scintillator shows up cascades involving more than two γ rays without any loss of efficiency, as shown on the ^{75}Se decay scheme as an example. (auth)

6899 CALIBRATION OF THE EFFICIENCY OF A Si(Li) PHOTON SPECTROMETER IN THE ENERGY REGION 5 TO 125 keV. Gehrke, R. J.; Lokken, R. A. (Idaho Nuclear Corp., Idaho Falls). Nucl. Instrum. Methods; 97: No. 2, 219-28(1971).

A technique for measuring the absolute photopeak efficiency of a 30-mm^2 × 3-mm Si(Li) spectrometer in the energy region from 5 to 125 keV is presented. The measurements are made by comparing the photopeak counting rate obtained from the Si(Li) spectrometer with the respective photon emission rate using a series of absolutely calibrated γ-ray sources. A simple procedure to obtain an accurate relative efficiency curve is also given. This alternate procedure measures the relative efficiency by using three readily available radionuclides (i.e., ^{145}Pm, ^{155}Eu, and ^{241}Am) whose relative photon intensities have been measured with the Si(Li) spectrometer calibrated for absolute photopeak efficiency. In addition, the K-conversion coefficients of the γ-ray transitions from ^{60m}Co (58.6 keV), ^{94m}Nb (40.7 keV) and ^{176m}Lu (88.4 keV) and the L-conversion coefficients for those of ^{192m}Ir (58.0 keV) and ^{210}Pb (46.5 keV) were determined from their X-ray/γ-ray intensity ratios and their respective fluorescence yields. The values obtained for these conversion coefficients are 42.1 ± 4.5, 995 ± 150, 1.18 ± 0.12, 2040 ± 430 and 14.3 ± 1.5, respectively. (auth)

6900 DIRECT GEOMETRY TIME-OF-FLIGHT SPECTROMETER AT THE DUBNA PULSED REACTOR. Deme, S. (Joint Inst. for Nuclear Research, Dubna, USSR); Kroo, N.; Szlavik, F.; Zsigmond, G. Nucl. Instrum. Methods; 97: No. 2, 371-5(1971).

A time-of-flight spectrometer has been constructed at the pulsed reactor in Dubna. The spectrometer works in the direct geometry with a phased chopper before the sample. The energy of the incoming neutrons can be varied in the 3 to 130 MeV range. Scattered neutrons can be analyzed simultaneously in 8 angles covering an angular region about 10° wide. By moving the detector arm a scattering angle region of ±65° can be covered. (auth)

6901 SIMULTANEOUS DETERMINATION OF FAST-NEUTRON SPECTRA BY TIME-OF-FLIGHT AND PULSE-HEIGHT UNFOLDING TECHNIQUES. Straker, E. A.; Burgart, C. E.; Love, T. A.; Freestone, R. M. Jr. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 97: No. 2, 275-82(1971).

Proton-recoil spectrometers have frequently been used in the past few years to measure spectra for neutron energies greater than approximately 1 MeV with the results depending strongly on the adequacy of the response matrix used in unfolding pulse-height spectra. By simultaneously measuring a fast-neutron spectrum by time-of-flight and by pulse-height unfolding, the adequacy of the response matrix and unfolding code could be determined. Spectra of several shapes and measurements with different time-of-flight resolutions were used to validate the spectra obtained by unfolding the pulse-height spectrum. (auth)

6902 AREA-OF-INTEREST UNFOLDING. Eckhoff, N. D.; Ervin, P. F. (Kansas State Univ., Manhattan). Nucl. Instrum. Methods; 97: No. 2, 263-6(1971).

The concept of area-of-interest (AOI) unfolding is developed. It is shown that in unfolding spectroscopic data not all the data are needed in the analysis. Further, the analysis results are improved in some cases by using data in small regions about photopeaks while eliminating Compton continuum data from the analysis. Since only a portion of the data is needed, computer time savings can be substantial. (auth)

6903 VERSATILE MOESSBAUER SPECTROMETER. Indurkar, V. S.; Patwardhan, P. K. (Bhabha Atomic Research Centre, Bombay). pp 551-9 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

6904 LOW-LEVEL COUNTING WITH Ge(Li) DETECTORS. Phelps, Paul L. (Mallinckrodt Inst. of Radiology, St. Louis). pp 165-89 of Role of Semiconductor Detectors in the Future of Nuclear Medicine. /Hoffer, Paul B. (ed.). New York; Society of Nuclear Medicine, Inc. (1971).

From Symposium on the role of semiconductor detectors in the future of nuclear medicine; Chicago, Ill. (12 Feb 1971).

The operation and performance of Ge(Li) detectors for low-level counting are discussed. Ge(Li) detector parameters, background and Compton radiation, counter shield construction, x-ray fluorescence production, cryostat considerations, signal processing, and anticoincidence spectrometers are discussed. (34 references.) (W.H.K.)

High Energy Physics Instrumentation

Refer also to abstracts 7598 and 7781.

6905 (BMBW-FBK-71-14) INVESTIGATIONS OF MAGNETOSTRICTIVE DELAY LINES FOR SPARK CHAMBER READOUT. Mittag, E. (Heidelberg Univ. (West Germany). Physikalisches Institut (I)). Oct 1971. 86p. (In German). Dep. NTIS (U. S. Sales Only).

A systematic description of the properties of magnetostrictive delay lines for spark chamber readout is given. Longitudinal sound waves in demagnetized round wires will produce a readout voltage which is approximately proportional to the second derivative of the chamber current. The damping is larger in magnetized round wires, also the signal is distorted over larger distances. In round wires torsional waves can be used too, having no dispersion and allowing larger wire diameters. No pulse distortion is observed for longitudinal waves in magnetized wire ribbons. Magnetostrictive delay lines are also suitable for long-time (>100 sec) signal storage. Secondary sparks from the chamber wires to the delay line will produce the highest signals, however, only one signal per delay line can be stored in this way. (auth)

6906 CONCERNING THE USE OF dE/dx SYSTEMS TO MEASURE THE CHARGE AND ENERGY OF RELATIVISTIC PARTICLES. Oran, W. A. (Marshall Space Flight Center, Huntsville, Ala.). Nucl. Instrum. Methods; 97: No. 1, 151-4 (1971).

A Monte Carlo program has been used to optimize the method of selectively averaging the pulse heights of a system of identical, specific energy loss detectors. The program simulated the interaction of energetic heavy charged particles whose specific energy losses were subject to Landau fluctuations. Distributions resulting from averaging the lowest 50% of the outputs from two to fourteen detectors are tabulated. In addition, a method which can measure the charge and energy of relativistic particles by using two dE/dx systems is described. (auth)

6907 DETERMINATION OF ENERGY AND CHARGE SPECTRA OF HIGH ENERGY COSMIC RAY NUCLEI USING GAS CHERENKOV COUNTER. Paul, J. M. (Louisiana State Univ., Baton Rouge). Nucl. Instrum. Methods; 97: No. 1, 155-60(1971).

The suitability of a gas Cherenkov counter for the determination of energy spectra of cosmic ray nuclei as well as charge composition from a few GeV to a few tens of GeV is investigated. It is found that for a counter with 5 GeV/nuc threshold energy and 100 cm radiating length, the energy resolution is 40% for protons up to 21 GeV and for alpha particles 30 GeV/nuc. With a 10 GeV/nuc threshold energy and for the same radiating length these limits are at 27.5 GeV for protons and 39 GeV/nuc for alpha particles for the same resolution. This resolution, however, steadily improves at lower energies. These results show that gas Cherenkov counters are superior in resolving power to most of the ionization spectrometers likely to be constructed for balloon and satellite payloads. Comparison with theoretical results shows that an ionization spectrometer in this energy interval has inferior resolution. (auth)

6908 DETECTION OF X-RAY TRANSITION RADIATION WITH MULTIWIRE PROPORTIONAL CHAMBERS. Uto, H.; Yuan, Luke C. L.; Dell, G. F.; Wang, C. L. (Brookhaven National Lab., Upton, N. Y.). Nucl. Instrum. Methods; 97: No. 2, 389-93(1971).

The X-ray component of the transition radiation generated by the traversal of high energy electrons through various radiators has been studied with multiwire proportional chambers in the electron beam of the Cornell 10 GeV Synchrotron. Radiators used include stacks of thin aluminum foils, stacks of thin sheets of Mylar and blocks of styrofoam. A chamber-radiator sandwich configuration (primarily to optimize the capture of low energy transition X-rays) is used. Results on the spectrum of the detected X-ray transition radiation in the presence of electron ionization are presented. The design of a detector for detection and identification of ultrarelativistic charged particles is discussed. (auth)

6909 SOME FEATURES OF LARGE MULTIWIRE PROPORTIONAL CHAMBERS. Charpak, G. (CERN, Geneva); Fischer, G.; Minten, A.; (and others). Nucl. Instrum. Methods; 97: No. 2, 377-88(1971).

Multiwire proportional chambers of about 150 cm × 40 cm designed to operate in a large magnet at the CERN Intersecting Storage Rings are described. Five chambers with three different orientations of the sensitive wires were built in a modular construction. Measurements on efficiency, noise, and time- and space-resolution are reported. (auth)

6910 DIRECT MOMENTUM DETERMINATION OF A MEDIUM-ENERGY PARTICLE BEAM USING TIME-OF-FLIGHT AND RANGE TECHNIQUES. Stevens, A. J. (Ohio State Univ., Columbus); Schwartz, D. M.; Rush, C. J.; (and others). Nucl. Instrum. Methods; 97: No. 2, 207-10(1971).

A direct measurement of the momentum of a particle beam with nominal momentum 1025 MeV/c is described. Time-of-flight and range techniques were employed to achieve a momentum determination of better than 0.2%. (auth)

6911 ON THE PRECISION OF MOMENTUM MEASUREMENTS WITH A MAGNETIC SPECTROMETER. Frohlich, A. (Tel-Aviv Univ., Israel). Nucl. Instrum. Methods; 97: No. 2, 315-18(1971).

Methods of analyzing the data from magnetic spectrometers are examined. The effects of Coulomb scatter counter efficiencies and assumed spectrum exponent on the observed spectra and how they might be incorporated into the analytic methods used for correcting the measured muon flux and charge ratio are considered. (auth)

6912 TRANSITION RADIATION DETECTOR DESIGN FOR COSMIC-RAY EXPERIMENTS. Ellsworth, R. W.; MacFall, J.; MacKeown, P. K.; Yodh, G. B. (Univ. of Maryland, College Park). pp 344-71 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. II. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.2).

An application is made of the theory of transition radiation to the problem of the measurement of the Lorentz factor ($\gamma = E/M$) of ultrarelativistic charged particles. The strong dependence of the radiation flux in the x-ray region on the Lorentz factor, γ, of the traversing particle makes the radiation suitable for measuring γ. The relevant properties of the transition radiation from a single interface are reviewed. The basic limitations with regard to formation distance and multiple scattering are discussed. The results are extended to a single foil and generalize to obtain the yield after n foils. Concise formulae for the x-ray spectra, total x-ray yield, and fluctuations in the yield are given. Radiator-counter arrangements that can be used for particle identification and energy determination of ultra-relativistic particles are discussed. (J.C.W.)

Radiation Dosimeters

Refer also to abstracts 6836, 7025, 7032, and 8579.

6913 (NP-19129) PRELIMINARIES TO EXTRACTING INFORMATION FROM DOSIMETRIC FILMS. Vesque, Jacques (Laboratoire Central de l'Armement, Arcueil (France)). 28 Oct 1970. 23p. (In French). Dep. NTIS (U. S. Sales Only).

The physical processes involved in the transformation of gamma ray energy into optical information in photographic emulsions was studied. The emulsions studied were envisaged for use in dosimetry. (France)

6914 (ORNL-TM-3572) PARAMETERS AFFECTING THE RADIATION-INDUCED THERMALLY STIMULATED EXOELECTRON EMISSION FROM CERAMIC BERYLLIUM OXIDE. Crase, K. W.; Becker, Klaus; Gammage, R. B. (Oak Ridge National Lab., Tenn.). Nov 1971. Contract W-7405-eng-26. 83p. Dep. NTIS. Thesis. Submitted by K. W. Crase to Univ. of Tenn., Knoxville.

The potential application in radiation dosimetry of the thermally stimulated exoelectron emission (TSEE) from BeO has been investigated, and efforts have been made to optimize its dosimetric properties. It has a three-peak emission spectrum, with a dominant peak at ~325°C, and two smaller peaks at ~450 and ~535°C, respectively. Changes in the sensitivity of the main peak following different heat treatments and chemical etchings have been related to the presence and state of silicon in the surface region. It is suggested that Si^{4+} substitutes for Be^{2+} and acts as an electron trap. BeO has also been bombarded with more than 10^{10} rad of deuterons, bringing about dramatic changes in its TSEE spectrum; namely, the ~450°C peak is greatly enhanced by such bombardment, while the ~325°C peak is obliterated by the intense localized heating. The radiation response characteristics of pretreated ceramic BeO have been studied for alpha, beta and gamma radiations. The main peak saturates at doses of approximately 1×10^5 and 2×10^4 rad for beta and gamma radiations, respectively, but no well-defined saturation was observed for alpha radiation up to 10^5 rad. An observed shift of the ~325°C TSEE peak temperature with increasing doses may be related to the energy width of the trapping level. The energy dependence of the electron response has been shown to vary roughly as the electronic stopping power in the 1–20 keV range. Doses of less than 0.1 mrad can be measured. Pairs of BeO detectors, only one being covered by a hydrogenous material, are suitable for highly sensitive and fairly energy-independent fast neutron measurement in mixed radiation fields. The incorporation of these dosimeters into a personnel dosimetry badge is discussed. (auth)

6915 METHODS FOR USING THE CONVENTIONAL $FeSO_4$ DOSIMETER TO MEASURE DOSES BELOW 1000 RADS. Law, J. (Royal Infirmary, Edinburgh). Int. J. Appl. Radiat. Isotop.; 22: No. 11, 701-3(Nov 1971).

Two methods of maintaining an adequate absorbance while decreasing the dose required to maintain maximum accuracy in using the $FeSO_4$ (Fricke) dosemeter are discussed. The first method is by increasing the path length of the spectrometer cell and the second is to make measurements at 224 nm instead of the usual 304 nm. Results obtained using these methods are tabulated. It is concluded that the use of 5 cm or longer path length cells has a considerable advantage in measuring doses of a few hundred rads. However, it is shown that even if the extinction factor

(ϵ) at 224 nm had no greater uncertainty than that at 304 nm, the precision of results at 224 nm would still be worse than at 304 nm. (UK)

6916 PHOTOCHROMIC RADIATION DOSIMETER. Harrah, Larry A. (to United States Atomic Energy Commission). U. S. Patent 3,609,093. 28 Sep 1971. Filed 11 Sep 1968.

A photochromic radiation dosimeter comprising a homogeneous mixture of a poly(halostyrene) host and a compound selected from the general structure of triarylmethane carbinols, ethers or azides substituted in one or more of the aryl moieties with hydroxyl or amine auxo-chromes is described. (W.H.K.)

6917 MECHANISM FOR NON-LINEARITY AND LET EFFECTS ON RESPONSE OF THERMOLUMINESCENCE DOSIMETER. Nakajima, Toshijuki (National Inst. of Radiological Sciences, Chiba, Japan). Hoshasen, Butsuri Kenkyu; 3: No. 2, 15-22(Apr 1970). (In Japanese).

Several models have been presented to explain non-linearity and LET effects in thermoluminescent dosimeters. In order to reexamine these models, glow curves were measured for TLD-100 LiF and TLD-200 CaF_2 (Mn) crystals at low temperature gradient rates, and their variation with absorbed dose was investigated. The shapes of the glow curves varied with the absorbed dose in a range of dose from 10^3 to 10^7 rad. In this range, no new glow peak was observed. The LiF crystal which was annealed at 300°C after the irradiation had the only glow peak at about 400°C. The variation of the shape of glow curves cannot be explained by the previous models. In order to explain this non-linearity and LET effects, a new model is presented. (Japan)

6918 SENSITIZATION IN LiF: TEFLON DOSEMETERS. Linsley, G. S.; Mason, E. W. Phys. Med. Biol.; 16: No. 4, 695-8(Oct 1971).

Experiments were made to determine the onset and magnitude of sensitization as a function of previous dose. The following annealing techniques were used: (1) 300°C for 20 minutes followed by 80°C for 24 hours; (2) 300°C for 16 hours followed by 80°C for 24 hours; and (3) 80°C for 24 hours. Samples of Con-Rad Type-7 LiF powder were treated with doses of ^{60}Co γ radiation from 0 rads to 1000 rads. Sensitization became apparent between 100 and 200 rads of previous dose for anneals 2 and 3 and after smaller doses for anneal 1. It is suggested that sensitization is cumulative with absorbed dose, and that the apparent lack at low doses was probably due to an inadequate effect rather than a genuine threshold phenomenon. (UK)

6919 AUTOMATIC DOSIMETER CHECKER. Walsh, M. L. (Ontario Hydro, Can.). Nucl. Instrum. Methods; 97: No. 2, 425-6 (1971).

An "automatic" dosimeter checker is described which substantially reduces the time required to give a direct-reading gamma dosimeter a constancy check. (auth)

6920 APPLICATION OF THERMOLUMINESCENCE TO THE ENVIRONMENTAL RADIATION MONITORING. Imai, Kazuhiko (Japan Atomic Energy Research Inst., Tokai). Genshiryoku Kogyo; 17: No. 7, 43-6(Jul 1971). (In Japanese).

Integrated dose is of prime importance for environmental radiation monitoring of nuclear facilities. Film and glass dosimeters have been used to date for routine measurement of the integrated dose. However, these dosimeters have some problems. Therefore, development of thermoluminescence dosimeters (TLD), especially as stable low dose dosimeters has been anticipated. Recently, reports from JAERI and a few nuclear facilities in the USA have been issued. There are LiF, natural CaF_2, CaF_2: Dy, $CaSO_4$: Mn, $CaSO_4$: Dy $CsSO_4$: Tm, and Mg_2SiO_4: Tb as TLD elements. The following properties are required of TLD elements for environmental monitoring: (1) sensitivity, (2) flat energy dependence, (3) low fading, (4) no self-dose, (5) product homogeneity, (6) no dependence on direction, (7) low sensitivity to light, (8) low sensitivity to temperature, and (9) low sensitivity to humidity. (Japan)

6921 CALORIMETER PAIR FOR DETERMINATION OF ABSORBED DOSE IN EPOXY AND CARBON IN SWIMMING-POOL-TYPE REACTOR. Sakata, Suoh (National Inst. of Radiological Sciences, Chiba, Japan); Inada, Tetsuo; Doke, Tadayoshi; Moriyama, Noboru; Katoh, Kazuaki. J. Nucl. Sci. Technol. (Tokyo); 8: No. 10, 563-8(Oct 1971).

A pair of adiabatic calorimeters were designed, constructed and applied to the estimation of the dose absorbed by epoxy resin, in a vertical experimental pipe of JRR-4 (swimming pool). One of the calorimeters was made of epoxy absorber, and the other of graphite (carbon). With this pair of calorimeters, the contributions of γ-rays and neutrons to the dose can be separately determined. The dependency of the dose upon the vertical location of the material in the experimental pipe was investigated with the reactor power set at 2.5 MW, and the dependency upon the reactor power was measured in the reactor power range of 0.05–2.5 MW. The calibration of the calorimeter output (V) to absorbed dose (rad) was made with a Fricke dosimeter in a γ-ray field. (auth)

6922 IMPROVEMENTS TO DOSIMETERS INCLUDED IN A RADIOACTIVITY SIMULATION UNIT. Dugault, Christian (to Laboratoire Central de l'Armement). French Patent 2,045,674. 5 Mar 1971. Filed 18 Jun 1969. (In French).

A dosimeter to be inserted in a radioactivity simulation unit is described. Its main part is a receiving system with direct amplification. The receiver transforms the hf signals emitted by the simulated source into a direct voltage. (France)

6923 RADIATION DOSE AND DOSE DISTRIBUTION MEASUREMENTS IN THE MEGARAD RANGE. Proceedings of Symposium Held at Teddington, England, July 6, 1970. Slough, Eng.; United Kingdom Panel on Gamma and Electron Irradiation (1971). 48p. (CONF-700659).

Separate abstracts were prepared for the eight papers presented. (W.H.K.)

For abstracts of individual papers see: 6924–6928 and 7030–7032.

6924 CALORIMETRY OF GAMMA AND ELECTRON RADIATION. Holm, N. W. (Danish Atomic Energy Commission, Risoe). pp 4-10 of Radiation Dose and Dose Distribution Measurements in the Megarad Range. Slough, Eng.; United Kingdom Panel on Gamma and Electron Irradiation (1971).

From Symposium on gamma and electron irradiation; Teddington, England (6 Jul 1970). See CONF-700659.

A general introduction to calorimetric principles is first given, followed by a discussion of some practical examples of calorimeters suited for standardization purposes in industrial ^{60}Co and electron accelerated plants. Topics include factors influencing the response of a calorimeter; methods of calorimetry, TAB energy distribution; auxiliary equipment; and calorimeters in practical use. (UK)

6925 RECENT DEVELOPMENTS IN POLYMETHYL METHACRYLATE/DYE SYSTEMS FOR MEGARAD DOSIMETRY. Whittaker, B. (Atomic Energy Research Establishment, Harwell, Eng.). pp 11-17 of Radiation Dose and Dose Distribution Measurements in the Megarad Range. Slough, Eng.; United Kingdom Panel on Gamma and Electron Irradiation (1971).

From Symposium on gamma and electron irradiation; Teddington, England (6 Jul 1970). See CONF-700659.

These systems depend on the spectrophotometric determination of irradiation induced optical absorption changes. Two kinds of commercial acrylic sheet materials are at present in use for dosimetric purposes—clear Perspex HX and dyed Perspex type Red 4034. On irradiation the former develops a new absorption band in the near UV (250 to 400 nm), and the intensity of the induced absorbance at 305 nm is used as a measure of dose. With the latter material the induced absorption band is in the visible region (600 to 700 nm) and a striking color change is observed (red → dark red → black); the induced absorbance at either 615 or 640 nm is used in dose determination. It is considered that a study of radiation coloration in these and other PMMA systems could lead to the development of better dosimetric materials. After a brief historical introduction to the subject, the development of new PMMA/dye systems is considered, including the use of Amber 3042 Perspex, which consists of a mixture of the azo dyes Sudon I and III. Mechanisms of radiation induced coloration are also discussed. (UK)

6926 PROBLEMS IN SPECTROPHOTOMETRY AND THEIR INFLUENCE IN RADIATION MEASUREMENTS. Ellis, S. C. (National Physical Lab., Teddington, Eng.). pp 18-23 of Radiation Dose and Dose Distribution Measurements in the Megarad Range. Slough, Eng.; United Kingdom Panel on Gamma and Electron Irradiation (1971).

From Symposium on gamma and electron irradiation; Teddington, England (6 Jul 1970). See CONF-700659.

The importance of accurate spectrophotometry in colorimetric methods for high dose measurement is emphasized and consideration is given to the factors that influence instrument performance including checking of wavelength scale, bandwidth considerations, signal-to-noise ratio, accuracy of optical density scale, effect of stray light, reflection from surfaces, and deflection by optically imperfect samples. Detailed consideration is given to the problems of spectrophotometry as they affect the Fricke dosemeter and the Perspex dosemeter. (UK)

6927 DYE FILMS AND GELS FOR MEGARAD DOSIMETRY. Hussmann, E. K.; McLaughlin, W. L. (National Bureau of

Standards, Washington, D. C.). pp 35-41 of Radiation Dose and Dose Distribution Measurements in the Megarad Range. Slough, Eng.; United Kingdom Panel on Gamma and Electron Irradiation (1971).

From Symposium on gamma and electron irradiation; Teddington, England (6 Jul 1970). See CONF-700659.

Difficulties associated in general with the use of organic materials for purposes of dosimetry are discussed, and certain exceptions are mentioned including dyed Perspex and dyed polyvinyl plastics. A description is then given of an organic system developed at the National Bureau of Standards Center for Radiation Research. The system shows remarkable versatility as a dosimeter and some unexpected useful properties in very high intensity pulsed beams: there are no apparent back reactions and the response is linear and shows essentially no rate dependence over the range 1 mR/sec to 10^{15} R/sec. There is also no appreciable temperature dependence. The system may be used in the liquid state or as thick gels in the kR range, or as thin film in the MR range, and is particularly useful in pulsed beam dosimetry and in high resolution imaging of intense radiation fields. It comprises an activated dye precursor, acidified pararosaniline cyanide being particularly efficient in this capacity; this is colorless before irradiation, but on irradiation develops absorption bands in the visible spectrum with very high optical extinction. Some experimental work is also described. Doses >120 kR caused bleaching with solutions, but this did not occur until >100 MR with film or gel. Some practical applications are also described, including dosimetry across interfaces, such as in bone trabecula. The system may be used for electron, x-, and γ irradiations. 25 references. (UK)

6928 HYDROGEN PRESSURE DOSIMETER. Stapleton, G. B. (Rutherford High Energy Lab., Chilton, Eng.). pp 42-6 of Radiation Dose and Dose Distribution Measurements in the Megarad Range. Slough, Eng.; United Kingdom Panel on Gamma and Electron Irradiation (1971).

From Symposium on gamma and electron irradiation; Teddington, England (6 Jul 1970). See CONF-700659.

The dosimeters described were initially developed for use in the very intense radiation fields around the Nimrod proton synchrotron at RHEL to assess radiation damage to accelerator components, but the design is such that it may find applications in other branches of radiation dosimetry where simple and inexpensive measurements of absorbed dose are required. The requirements for dosimeters for use in accelerators are first stated, together with problems encountered with early type dosimeters. A system that appears very promising involves measurement of gas evolution from polyethylene irradiation, the total gaseous degradation products of which comprise 97 to 99% H_2. The quantity of H_2 evolved is related to the integrated radiation dose and measurement of the pressure build-up in a sealed capsule containing the polyethylene thus gives a measure of total dose. Two types of dosimeters using this principle have been developed and are described; these are known as the Continuous Reading Remote Dosimeter and the Total Dose Frangible Dosimeter. It is emphasized that these devices are intended as a means of measuring exposure dose and not primarily as a means of determining total energy absorption. The TDFD appears to be the better system, and its current range is 5×10^5 to 1.5×10^8 R, which probably can be extended in both directions without any significant loss of sensitivity. The devices are in service on the Nimrod accelerator (RHEL) and Nina (Daresbury Nuclear Phys. Lab). (UK)

6929 METHOD AND APPARATUS FOR MEASURING THE ENERGY AND/OR DOSE OF RADIATION BY RADIATION-SENSITIVE TRANSPARENT SOLID BODY MEASURING ELEMENTS. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,248,965. 6 Oct 1971. Priority date 28 Nov 1967, Germany.

A readout system for ultraviolet-excited photoluminescent dosimeters is described. (W.H.K.)

6930 THERMOLUMINESCENT PHOSPHOR. Nada, Naohiro; Yamashita, Tadaoki (to Matsushita Electric Industrial Co. Ltd.). British Patent 1,248,777. 6 Oct 1971. Priority date 12 Oct 1967, Japan.

A process for the production of a thermoluminescent phosphor for dosimetry is described. The phosphor is composed of beryllium oxide and/or beryllium sulfate with a small amount of at least one of the activator elements Li, Na, K, Si, Ge, Sn, Zn, Cd, Al, Tl, V, and Yb. The mixture is sintered at a temperature of 1500 to 2100°C in an oxidizing atmosphere. (W.H.K.)

6931 SEQ-6 POCKET DOSIMETER. Courtaud, B. (Societe La Physiotechnie, Arcueil, France). Bull. Instrum. Nucl.; No. 42, 70-2(Jan 1971). (In French).

A direct reading quartz fiber pocket dosimeter is described. It can be used for electron beams (β particles or electrons from an accelerator) or for photons with energies greater than 10 keV (x and γ rays and bremsstrahlung radiation). An accuracy of better than 10 percent is achieved in all cases. (France)

Radiometric Instruments

Refer also to abstract 6801.

6932 (STI/DOC-10/130) COMMERCIAL PORTABLE GAUGES FOR RADIOMETRIC DETERMINATION OF THE DENSITY AND MOISTURE CONTENT OF BUILDING MATERIALS. A Comparative Study. Honig, A.; Pospisilova-Rothscheinova, Ludmila; Klablena, P.; Habarta, J. (International Atomic Energy Agency, Vienna (Austria)). Sep 1971. 210p. IAEA $6.00.

Various commercially-available backscatter subsurface density gages, backscatter surface density gages, subsurface moisture probes, and surface moisture probes were tested, and the results are presented. A total of 10 manufacturers supplied 25 subsurface and surface probes, some of which were multimode operative, so that essentially a total of 37 probes were evaluated. Parameters tested include sensitivity and measuring time, resolution, depth-sampling characteristics of surface probes, daily and weekly stabilities of equipment, stability of equipment under extreme temperature conditions (−10 to 40°C), characteristics under field conditions, and radiation hazards. (W.H.K.)

6933 RADIATION QUALITY GAUGE. Senda, Tomio; Hirayama, Kazuo (Osaka Univ.). Keikinzoku Yosetsu; No. 99, 144-53(Mar 1971). (In Japanese).

Materials of penetrometers employed in radiation penetration tests are required to be the same as that of test samples or to have similar radiation absorption. Recently, however, since various welded and cast metals and alloys are radiation tested, it is often difficult to prepare the penetrometers of the same material as the test samples. Due to this situation, radiation quality gages have been developed in order to be able to convert penetrometer discrimination, even though the penetrometers of different material are used. The gage used for this experiment is composed of stepped aluminum plates and a flat titanium plate, and it was assured to be possible to measure ratio of two x-ray absorption coefficients. Equations representing relations between the penetrometer discrimination and radiographic conditions are also discussed. Tests were carried out with the penetrometer of aluminum on a titanium sample. As a result, it is shown that practically valid penetrometer discrimination can be obtained if the radiation quality gage is employed in the radiation penetration test. (Japan)

6934 PRESS SECTION AND FELT EVALUATION WITH A PORTABLE GAMMA RADIATION INSTRUMENT. Antos, David P.; Baade, Donald E. (Huyck Felt Co., Rensselaer, N. Y.). Tappi; 54: No. 9, 1505-8(Sep 1971).

A new measuring instrument has been evaluated that will measure cross-machine variation in wet felts and heavier weight sheets at the press section. The instrument is ideally suited to detect variations caused by improper press roll crown or unequal press roll loading. The instrument measures mass density by means of backscattered radiation from an americium 241 source. The small size and weight of the instrument allow measurements in extremely confined locations which would otherwise not be accessible. Measurements before and after Uhle boxes and wringer presses, to evaluate their water removal efficiency, are another important application. Studies measuring heavy sheets in the dryer section to determine drying rate curves have been conducted. Used in conjunction with a microwave moisture measuring instrument, a complete breakdown of moisture content and moisture-free felt weight is feasible. (auth)

6935 CONTINUOUSLY MEASURING AND CONTROL INSTALLATIONS IN THE WIRE INDUSTRY. Knuefelmann, M. Draht.; 21: No. 4, 223-4(1970). (In German).

The measuring principle and operation of semiautomatic and fully automatic nuclear gages for thickness testing using ^{241}Am–γ–rays are described. (INIS)

Miscellaneous Instruments and Components

Refer also to abstracts 6493, 6828, 7028, 7716, 7717, 8109, 8271, and 8605.

6936 (CEA-N-1491) TIME-TO-AMPLITUDE CONVERTER WITH A VERY SMALL ELECTRONIC RESOLVING TIME (2.2 PS).

Van Zurk, R. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Sep 1971. 16p. (In French). Dep. NTIS (U. S. Sales Only).

A time interval analyzer, which uses an original time-to-amplitude converter is described. This converter functions in conjunction with two fast gates using snap-off diodes, controlled by a semi-fast channel. The behavior of the time-to-amplitude converter is briefly discussed. The resolution time of the analyzer is 2.2 psec (full width at half height). (France)

6937 (CERN-71-22) FIVE-CHANNEL STROBED COINCIDENCE UNIT. Moore, M.; Verweij, H. (European Organization for Nuclear Research, Geneva (Switzerland)). 28 Oct 1971. 18p. Dep. NTIS (U. S. Sales Only).

The instrument to be described contains five independent single-input channels which can be gated by a common "strobe" signal. Each channel has a front-panel switch giving the choice of making it subject to the common signal or not. The minimum input width is 1.5 nsec and the minimum strobe width is 2 nsec. The maximum frequency of operation is at least 50 MHz with the standardized output width of 8.5 nsec and could be increased by reducing the output width. One logic and one complementary logic output are provided for each channel. The unit, type N6236, has been designed to accept standard NIM signal levels and is part of the CERN-NIM compatible nucleonic instrument range. (auth)

6938 (DP-1175) DIGITAL DATA ACQUISITION AND CONTROL FOR A MASS SPECTROMETER. Byrd, J. S. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Oct 1971. Contract AT(07-2)-1. 11p. Dep. NTIS.

A digital system has been built to automatically punch mass spectrometer data on IBM cards for computer processing and also to control the acceleration potential of the spectrometer. The system can be operated in two scan control modes with the mass spectrometer, and a data logging mode is provided for other laboratory applications. (auth)

6939 (KFK-1471) CAMAC BIBLIOGRAPHY. Tradowsky-Thal, I. (Kernforschungszentrum, Karlsruhe (West Germany). Labor fuer Elektronik und Messtechnik). Sep 1971. 59p. (In several languages). Dep. NTIS (U. S. Sales Only).

The bibliographical references and the abstracts, if given by the author, of the publications on the CAMAC system up to August 1971, are presented. Each of the 114 citations is placed on a 14.8 mm × 10.5 mm field with abstract on the back. (auth)

6940 (RFP-1653) LEVEL INDICATOR USING SAMPLING METHODS. Sheets, Warren R. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 22 Nov 1971. Contract AT(29-1)-1106. 3p. Dep. NTIS.

An instrument is described for sampling fissile solution levels during critical mass experiments using a conductance probe sensor. Readout is performed on a simple scale and interpolation dial during hold periods of the instrument. Repeatability of fixed level readings is within ±0.05 millimeters. The sampling rate is approximately two per minute. The sequence of operation starts with a hold period for reading, next a probe lift period, and finally a probe return which provides the next reading. (auth)

6941 (SRARI-P-68) DOUBLE DELAY PULSE SHAPING CIRCUIT WITH A MODIFIED NOISE SPECTRUM FOR A HIGH RATE OPERATION IN HIGH-RESOLUTION AMPLITUDE SPECTROMETERS. Ivanov, V. B.; Shipilov, V. I. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1970. 19p. (In Russian). INIS.

A shaper for double linear delay pulses with a modified noise spectrum is described. The shaper allows reduction of the noise level as compared with common filters, and performs accurate amplitude measurements at high incoming charges (up to 10^5 imp/sec). Deterioration of the resolution in comparison with results at low charges is not more than 0.4 to 0.7 keV. The calibration scale remained unchanged during changes in charge. (tr-auth)

6942 (UCRL-20426, pp 271-310) INSTRUMENTATION AND SYSTEMS DEVELOPMENT. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1971.

From Nuclear chemistry.

6943 MAGNETOSTRICTIVE DELAY LINES FOR OUTER DIGITAL PROCESSING SYSTEMS. Adminis, A. E.; Budris, M.-V. K.; Kiselev, E. K.; (and others). (Electrical Engineering Inst., Leningrad). Nucl. Instrum. Methods; 97: No. 1, 177-80 (1971).

Utilization of magnetostrictive delay-line storage to discharge the communication channels between the central computer and outer analog-to-digital converters is discussed. Examples are given of the utilization of two synchronized delay lines, each having a 500 kHz clock frequency and a 1024-bits capacity, in the pulse height analyzer, using continuous storing of flowing spectra simultaneously with the output of the preceding amplitude spectrum. In the same analyzer the spectrum area as well as the areas of its four preset regions are computed simultaneously with the spectrum storing. Four delay lines, each having a 2 MHz clock rate and a 2048-bits capacity, are used in the 512-channel pulse height analyzer. Eight delay lines of the same type are used in the 2048-channel time selector, its dead time being equal to the (0.5; 1; 4 μs) time channel band width. Five delay lines, each having a 2 MHz clock frequency and a 32-bits capacity, are used in the four-dimensional non-integrating pulse height analyzers as time-to-binary code converters and as digital integrators of the peak and zero stabilizers of each analog-to-digital converter. (auth)

6944 DYNAMICAL GAIN MEASUREMENT OF A GALLIUM PHOSPHIDE DYNODE. Miehe, J. A.; Knispel, G. (CRN, Strasbourg). Nucl. Instrum. Methods; 97: No. 1, 195-7(1971).

The variation of the secondary emission yield as a function of voltage, of the gallium-phosphide first dynode in C 31000 D photomultipliers is deduced by measuring successively the gain of the phototube when a single photoelectron releases the photocathode and when an electron is produced by the photoelectric effect on the GaP dynode. In addition, the time of flight of single photoelectrons between the first dynode and the photocathode is measured by using a fast-slow coincidence circuit. (auth)

6945 PROCEEDINGS OF THE 17th ANNUAL ISA ANALYSIS INSTRUMENTATION SYMPOSIUM, APRIL 19-21, 1971, HOUSTON, TEXAS. Bartz, A. M.; Chapman, R. L.; Fowler, Lewis (eds.). Anal. Instrum.; 9: A.1.1-K.1.1(1971). (CONF-710420).

Separate abstracts were prepared for 3 of the 47 papers presented. One paper was previously included in NSA and the remaining 43 papers were not in scope. (W.H.K.)

For abstracts of individual papers see: 6493, 6946, and 6947.

6946 HIGH CONCENTRATION ISOTOPIC SOURCE NONDISPERSIVE X-RAY FLUORESCENCE CONTINUOUS PROCESS ANALYZER. Sims, R. W.; Parks, J. C.; King, F. E. (Monsanto Co., Texas City, Tex.). Anal. Instrum.; 9: F.1.1-9(1971).

From seventeenth annual ISA analysis instrumentation symposium; Houston, Tex. (19 Apr 1971).

Geometry effects such as source-sample distance and sample thickness, sample backscatter, matrix and particle size effects that affect the calibration and the accuracy of the prototype analyzer were investigated. Factors affecting reproductibility and long term stability were also established. (auth)

6947 ENERGY DISPERSION X-RAY (EDX) ANALYSIS IN THE NON-FERROUS MINING INDUSTRY. Langheinrich, A. P.; Forster, J. W.; Linn, T. A. Jr. (Kennecott Copper Corp., Salt Lake City). Anal. Instrum.; 9: F.3.1-14(1971).

From seventeenth annual ISA analysis instrumentation symposium; Houston, Tex. (19 Apr 1971).

Energy dispersion X-ray equipment in combination with radioisotope sources was used successfully in the analysis of mining and milling samples for copper, iron, molybdenum, lead, zinc, and uranium. Sample types included solid materials, solutions, muds and slurries. A variety of modular combinations of sources, sample cells, Si(Li) detectors, amplifiers, single- and multi-channel analyzers, scalers, rate meters, printers and recorders was utilized to fit particular jobs. Test results and field applications have demonstrated the value of EDX instrumentation as an analytical tool. Its future wide use in the laboratory, the pilot plant and process plant is to be expected. Energy dispersion X-ray equipment has also been applied to the qualitative and semi-quantitative X-ray diffraction analysis of minerals. (auth)

6948 SMALL SAMPLE METHOD FOR INVESTIGATION OF THE (n,n'γ) REACTION. Elbakr, S. A.; Van Heerden, I. J.; Dawson, W. K.; McDonald, W. J.; Neilson, G. C. (Univ. of Alberta, Edmonton). Nucl. Instrum. Methods; 97: No. 2, 283-9 (1971).

A technique has been developed which makes it possible to study (n,n'γ) experiments using very small scattering samples in a close geometry. Data are presented for a 3.147 g natural Fe target and a 6.960 g Sm_2O_3 target enriched to 99.54% in ^{154}Sm. The results indicate that the method can yield useful results for samples of this size. To show that reliable yield curves can be obtained with the present technique, the excitation curve for the 847 keV γ ray from ^{56}Fe has been measured. Because of the close geometry, an unfolding routine was employed to account for the angular distribution and energy variation of the neutrons as well as the attenuation of γ rays in the scatterer. The resulting yield curve is in good agreement with previous measurements. (auth)

6949 COMPUTER-COMPUTER LINK BETWEEN A PDP-7 AND A PDP-15. Tighe, L. E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, Australia). Nucl. Instrum. Methods; 97: No. 2, 417-18(1971).

Two adjacent computers are linked so that the peripheral devices connected to each become available to both. One computer is master and the other is slave. (auth)

6950 DISPLAY PROGRAM FOR INFORMATION FROM AN IBM 1800 COMPUTER. Ring, C.; Bueb, B.; Wittmer, P.; Wery, M. (CRN, Strasborug-Cronenbourg, France). Nucl. Instrum. Methods; 97: No. 2, 395-7(1971). (In French).

An Intertechnique display unit (RG 96) is connected to a digital output of an IBM 1800 computer. The control unit is designed to minimize the amount of data transmitted by the computer to build a given graph. (auth)

6951 TWO VERNIER TIME-INTERVAL DIGITIZERS. Barton, R. D.; King, M. E. (Carleton Univ., Ottawa, Can.). Nucl. Instrum. Methods; 97: No. 2, 359-70(1971).

Two vernier time-interval digitizers are described. One, made of EG and G modules, has a minimum useful channel width of about 200 ps. The other, made of MECL II integrated circuitry, works at channel widths greater than 10 ps. They are inexpensive, easily made, linear, stable and fast. In many applications their digitizing rate of 20 MHz (which is variable) yields shorter total busy times than for a TAC-ADC system because of the absence of a leading dead time. For anyone with access to an on-line computer, the MECL II device reduces the cost of digitizing time intervals by more than an order of magnitude over commercially available systems and the device is so easily assembled that almost anyone can make his own. Their range of applicability is discussed and shown to cover all the practical nuclear lifetime and time of flight situations. (auth)

6952 DECAY TIME MEASUREMENT WITH TWO PHOTOMULTIPLIERS IN SINGLE PHOTOELECTRON CONDITION. D'Alessio, J. T.; Zampach, J.; Kesque, J. M. (Comision Nacional de Energia Atomica, Buenos Aires). Nucl. Instrum. Methods; 97: No. 2, 235-41(1971).

By means of the single photoelectron method the I(t) luminous function can be determined in phenomena which are within the region of the nano- and sub-nanosecond, as well as for extremely weak intensities, but with the condition of having the adequate reference pulse, which limits its possibilities. A method is proposed in which two photomultipliers are used, under single photoelectron conditions, and this makes said reference pulse unnecessary. A simple relation between the results obtained with one and two photomultipliers under single photoelectron conditions has been found, and these results have been mathematically justified for several typical cases. The practical application of the method, which allows measurements of intensities within the range of 10^{-14}–10^{-15} lm presents no difficulties. (auth)

6953 MISMATCH ORIENTED CIRCUIT DESIGN AND ITS APPLICATION TO NUCLEAR ELECTRONICS. Arbel, Arie F. (Technion-Israel Inst. of Tech., Haifa, Israel). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 4, 3-15 (Aug 1969).

Consistent application of mismatch between source and load is shown to lead to the design of feedback amplifiers, whose characteristics closely approach those of idealized "black boxes" exhibiting zero or infinite input and output impedance levels. The resulting configurations are shown to employ enhancing combinations between four kinds of basic amplifiers and series or shunt feedback applied to their input and output, respectively. Depending upon the signal parameter employed, the input and output terminals of the "black boxes" will operate in the voltage or in the current mode, each emerging in its own rights as the preferable technique if employed under proper conditions. Enhancing combinations result in greater flexibility of usable gain values and functions, and in reduced noise contribution to the preceding stage. Further extension of mismatch to active circuit design makes it possible to employ a greatly simplified transistor model, and restricts the dominant poles to those which are unavoidably introduced by the active elements. The resulting "standard" circuits are readily reproducible by conventional manufacturing methods, and further improvement of their performance is predicted through the application of microcircuit techniques. The design of a high resolution spectrometer is described, which employs enhancing combinations of such standard circuits. The choice of the most suitable circuit for each stage depends on the preferred signal parameter, noise considerations, and gain requirements. (auth)

6954 ION-OPTICS OF A SPLIT-POLE MAGNETIC SPECTROGRAPH BY METHOD OF RAY-TRACING. Das, S.; Sarma, N. (Bhabha Atomic Research Centre, Bombay). pp 661-4 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

6955 SAMPLING DEVICE FOR RADIOACTIVE AEROSOLS. Garnier, Andre French Patent 2,063,802. 14 Jun 1971. Filed 31 Oct 1969. (In French).

A portable apparatus that can be used to continuously sample an atmosphere contaminated by radioactive aerosols is described. It consists of a casing with an opening in which a filter support and a blower are sealed and contains a battery which drives a motor. The blower discharge valve is mounted on a collar supporting the filter in such a way as to reject the atmosphere drawn in across the filter towards the outside of the box. The casing is constructed from a molded plastic material. The sealing is effected between the collar and the casing at one end of this blower. (France)

6956 INDUCTIVE EXTENSOMETERS FOR MATERIALS TESTING. Buresch, F. E. (Kernforschungsanlage, Juelich, Ger.); Schimmer, L. Materialpruefung; 13: No. 4, 109-12 (1971). (In German).

The electromechanical inductive extensometers have proved to be very useful especially for testing metals, ceramics, plastics and rubber. Small and large inductive extensometers are now available to measure both the expansion of very small specimens, which are used in nuclear reactors and for aviation and space purposes, and the elongations of plastic materials or the crack opening displacement. The calibration characteristics of these apparatus are linear even below the limit of 1 μm and free from hysteresis. A magnification of 12,500 can be obtained very easily. Finally, different apparatus based on new principles are described. These can be utilized not only for short-time experiments at room and elevated temperatures but also for long-time experiments performed under a constant or alternating load. (INIS)

6957 D.C. PERIODMETERS: CHARACTERISTICS AND TEST METHODS. IEC Publication 295 1969. Geneva; Bureau Central de la Commission Electrotechnique Internationale (1969). 36p. (In French and English). Available from American National Standards Institute, New York.

An IEC recommendation to establish standards concerning the electrical characteristics and test methods for dc periodmeters is presented. (W.H.K.)

6958 EXTERNAL DIAMETER OF PLANCHETS USED IN NUCLEAR ELECTRONIC INSTRUMENTS. IEC Publication 248 1967. Geneva; Bureau Central de la Commission Electrotechnique Internationale (1967). 5p. (In French and English). Available from American National Standards Institute, New York.

An IEC recommendation which gives the standard values for the external diameter of planchets used in nuclear electronic instruments in connection with ionizing radiation is presented. (W.H.K.)

6959 ANALOGUE VOLTAGE RANGES AND LOGIC LEVELS FOR MAINS OPERATED NUCLEAR INSTRUMENTS. IEC Publication 323 1970. Geneva; Bureau Central de la Commission Electrotechnique Internationale (1970). 7p. (In French and English). Available from American National Standards Institute, New York.

An IEC recommendation to establish standard voltage ranges and maximum permissible output voltages for analog signals and output impedances for analog circuits and to establish digital logic levels for binary signals for mains operated nuclear electronics instruments is presented. (W.H.K.)

6960 SUPPLY VOLTAGES FOR TRANSISTORIZED NUCLEAR INSTRUMENTS. STABILIZED D.C. POWER SUPPLIES: TOLERANCES OF VOLTAGES. IEC Publication 293A 1970. Geneva; Bureau Central de la Commission Electrotechnique Internationale (1970). 7p. (In French and English). Available from American National Standards Institute, New York.

An IEC recommendation for mains operated stabilized dc power supplies for transistorized instruments used in nuclear electronics is presented. The tolerances of standard stabilized dc power supply voltages are specified with respect to changes in mains voltage and load and to changes in ambient temperature. (W.H.K.)

6961 SUPPLY VOLTAGES FOR TRANSISTORIZED NUCLEAR INSTRUMENTS. IEC Publication 293 1968. Geneva; Bureau Central de la Commission Electrotechnique Internationale (1968). 7p. (In French and English). Available from American National Standards Institute, New York.

An IEC recommendation for standard values and tolerances of nominal ac mains supply voltages and frequencies for nuclear instruments and standard values of nominal stabilized dc supply voltages for dc supply of nuclear instruments by mains-operated stabilized dc sources that are not an integral part of the instrument is presented. (W.H.K.)

6962 L.E.T.I. WORKS IN BIOMEDICAL ENGINEERING. Bull. Inform. Sci. Tech. (Paris); No. 156, 23-7(Feb 1971). (In French).

The results of the studies carried out at the L.E.T.I. in the past few years and the devices designed in biomedical engineering are presented: investigation about human eye movement; blood flow index measurement; x and γ rays multidetectors; automatic detection of wave and spike in electroencephalograms; electronystagmography; investigation about sensitivo- and sensoriomotor circuits; cerebral blood flow measurement with ^{133}Xe; intravascular semiconductor probes. (France)

Radiation Effects on Instruments and Instrument Components

6963 RESULTS OF A COMPUTER PREDICTION OF AFTER-RADIATION RELIABILITY. Breipohl, Arthur M. (Univ. of Kansas, Lawrence); Corbett, Wayne T. IEEE (Inst. Elec. Electron Eng.); Trans. Rel.; R-20: No. 3, 154-8(Aug 1971).

The results of predicting the reliability of a circuit at different radiation levels are presented. The conditional mean and variance of circuit output and the conditional reliability are predicted using Sceptre and test data on components exposed to different levels of radiation. These predictions are compared with the results of tests of the circuit. The difference between predictions and tests is examined and explained. The conclusions suggest a minor modification of the proposed method. It is also suggested that this method of computer-aided reliability prediction can be a valuable design aid. This is especially true when there is a significant effect due to environmental variation, such as the effect of radiation on semiconductors. (auth)

6964 EFFECT OF NEUTRON RADIATION ON A SILICON CARBIDE p–n JUNCTION. Sirota, N. N.; Korshunov, F. P.; Gatal'skii, G. V.; Bozhok, G. V. (Inst. of Physics of Solids and Semiconductors, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 3, 109-11(1971). (In Russian).

Experimental results are given for the effect of reactor-generated neutrons on p–n that originally possessed a specific resistance of 0.1 to 0.01 ohm-cm. The changes in the volt–ampere characteristics were measured for an integral neutron flux of over 10^{14} n/cm^2. A significant drop in the intensity of recombination radiation was noted, starting at a flux of about 10^{12} n/cm^2. (tr-auth)

6965 SURFACE EFFECTS OF RADIATION ON MOS DIODES. Yamaguchi, Masafumi; Nagai, Osamu (Ibaraki Electrical Communication Lab., Tokai, Japan). Jap. J. Appl. Phys.; 10: No. 12, 1733-4(Dec 1971).

A study was made of the effects of gamma irradiation on MOS diodes made from n-type P-doped Si wafers oriented in the (111) direction by thermal oxidation and Al evaporation. Measurements of capacitance-voltage (C–V) characteristics were made to detect the radioinduced space charge. The voltage shift at the flatband condition of the C–V curves is plotted as a function of dose. The effects of oxidation atmosphere at 1200°C on the space-charge buildup were studied. The diffusion coefficient of the space charge in SiO_2 was determined from isothermal annealing experiments. The activation energy for recovery was ~0.2 eV. (D.L.C.)

6966 EFFECTS OF RADIATION ON SILICON PLANAR TRANSISTORS. Yamaguchi, Masafumi; Nagai, Osamu (Ibaraki Electrical Communication Lab., Tokai, Japan). Jap. J. Appl. Phys.; 10: No. 12, 1735-6(Dec 1971).

The effects of gamma rays or 20-MeV electrons on Si n-p-n planar transistors were studied, and an attempt was made to separate surface effects from bulk damage. The common emitter dc gain h_{FE} was measured as a function of dose, and the base current components of $1/h_{FE}$ were estimated. (D.L.C.)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstract 6697.

Basic Processes

Refer also to abstract 7026.

6967 ASSAY OF AUSTRALIA ANTIGEN AND ANTIBODY EMPLOYING DOUBLE-ANTIBODY AND SOLID-PHASE RADIOIMMUNOASSAY TECHNIQUES AND COMPARISON WITH THE PASSIVE HEMAGGLUTINATION METHODS. **Hollinger, F. Blaine; Vorndam, Vance; Dreesman, Gordon R. (Baylor Coll. of Medicine, Houston, Tex.). J. Immunol.; 107: No. 4, 1099-1111(Oct 1971).**

Australia antigen (Au) and antibody were assayed by double-antibody (RIA-DA) and solid-phase radioimmunoassay methods and the results were compared with those of other serodiagnostic tests. Purified Au (72 μg protein/ml and approximately 10^{13} particles/ml) was prepared and labeled with ^{125}I. The use of a 2-day RIA-DA procedure (anti-Au + unknown, 6 hr; labeled Au, 18 hr; immunoprecipitating antibody, 24 hr) resulted in Au titers that were usually 5- to 35-fold greater than those obtained by the complement fixation (CF) method, and 5- to 10-fold greater than those resulting from the passive hemagglutination (PHA) inhibition procedure. Shortening the RIA-DA procedure to 1 day or using antibody-coated tubes in a solid-phase radioimmunoassay system resulted in Au titers that were two- to threefold less than those obtained by the longer RIA-DA method, although both immunoassays were more sensitive than the CF test. RIA-DA and PHA anti-Au titers were comparable. (auth)

6968 RADIOISOTOPE PRECIPITATION TESTS WITH ^{14}C AND ^{51}Cr LABELED VACCINIA ANTIGENS. **Felsenfeld, Oscar; Dutta, Nirmal K.; Felsenfeld, Ambhan D.; Brannon, Richard B. (Tulane Univ., Covington, La. Haffkine Inst., Bombay). Proc. Soc. Exp. Biol. Med.; 138: No. 1, 149-51 (Oct 1971).**

The radioisotope precipitation test was performed with ^{14}C and ^{51}Cr labeled vaccinia antigens after primary smallpox vaccination. The test gave positive results with the sera of successfully vaccinated individuals for a longer time than the neutralization test. (auth)

6969 CONVECTIVE DIFFUSION OF TRACERS. **Norwich, K. H. (Univ. of Toronto). J. Theor. Biol.; 32: 47-57(1971).**

Isotopic tracers and the substances which they trace (tracees) are transported by two means. They are entrained by the fluid which carries them, and thus they share the motion of the fluid; and they diffuse at rates and in directions determined by their concentration gradients. The equations of convective diffusion (the combination of these two processes) are derived for tracer and tracee. These equations are examined for several special cases: where convection predominates in the transport process, where the tracer is an indicator, and where steady state prevails. The analysis of experiments involving a constant infusion of tracer is discussed for the case where both tracer and tracee are in steady state. (auth)

Metabolism, Physiology, and Toxicology

Refer also to abstract 6998.

6970 BIOLOGICAL HALF-LIFE ON ^{137}Cs AND ^{24}Na IN MAN. **Haesaenen, E.; Rahola, T. (Helsinki Univ. of Tech., Otaniemi, Finland. Univ. of Helsinki). Ann. Clin. Res.; 3: 236-40(1971).**

Excretion of ^{137}Cs and ^{24}Na and the factors affecting it were studied in 10 healthy men. The biological half-life found for ^{137}Cs was 84 days (52 to 104 days) and that for ^{24}Na 9.3 days (5.1 to 13.1 days). The amounts of exchangeable sodium was, on the average, 1.14 g/kg and cesium 0.025 mg/kg. The biological half-life of ^{137}Cs was found to be significantly correlated with the amount of ^{137}Cs excreted in urine during the first 24 hours after a single oral dose ($r = 0.83$, $p < 0.001$) and with the amount of sodium excreted in urine ($r = -0.81$, $p < 0.01$). The biological half-life of ^{24}Na was found to be correlated with the amount of stable sodium excreted in urine ($r = -0.71$, $p < 0.01$). (auth) (Finland)

6971 INVESTIGATIONS ON THE EFFECTS OF DEUTERATION ON SOME FUNCTIONS OF BIOLOGICAL MEMBRANES. **Vasilescu, V.; Margineanu, D. (Inst. of Medicine and Pharmacy, Bucharest). Rev. Roum. Physiol.; 8: No. 3, 217-26(1971).**

Changes occurring in the functioning of some membranes and biological barriers when water was replaced by D_2O were studied. If D_2O was substituted for 99% of the water, the active transport of sodium ions through frog skin was abolished. The electrobiogenesis of nerve fibre isolated by the Tasaki technique was studied separately. If the fibre was immersed in D_2O Ringer, its electrobiogenesis was suppressed. The high resolution NMR spectra revealed a change in the proton configuration of the nerve placed in D_2O, a change corresponding to its abolished electrobiogenesis. D_2O also suppressed the contractile function of striated muscle in the isolated heart. Both the abolishment of electrobiogenesis and that of the contractile function are reversible processes. Reimmersing the nerve fibre or muscle in normal Ringer solution restores their functions. To explain these phenomena, one must take into account the contribution of the protons to the energetic mechanisms conditioning the processes studied and, on a more general level, the function of the biological systems. (auth)

6972 ETHYLENEDIAMINETETRAACETIC ACID AND ^{65}Zn BINDING BY INTESTINAL DIGESTA, INTESTINAL MUCOSA, AND BLOOD PLASMA. **Suso, F. A.; Edwards, H. M. Jr. (Univ. of Georgia, Athens). Proc. Soc. Exp. Biol. Med.; 138: No. 1, 157-62(Oct 1971).**

The mechanisms of zinc absorption and the effect of EDTA (ethylenediaminetetraacetic acid) on zinc absorption were studied at the intestinal digesta, intestinal mucosa, and blood plasma levels. Dialytic and gel filtration studies showed complexing of ^{65}Zn with free amino acids or EDTA-^{14}C in the intestinal digesta. The EDTA-^{14}C: ^{65}Zn complex was bound to a zinc binding protein in the intestinal mucosa (mol wt 14,000–18,000) and to a plasma protein (mol wt 65,000–70,000), that had a greater affinity for zinc than the mucosal protein. The ratios obtained for the cpm EDTA-^{14}C: cpm ^{65}Zn in the main peaks eluted from gel filtration columns (1.10 in intestinal digesta preparation, 1.26 in mucosa soluble fractions, and 1.26 in blood plasma) indicated strong binding of the EDTA-zinc complex. When EDTA was not present in the diet, ^{65}Zn complexed with amino acids in the intestinal digesta and with the same mucosal and blood proteins. (auth)

6973 EFFECT OF X-IRRADIATION ON PROTEIN SYNTHESIS IN PIG THYROID MICROSOMAL SUSPENSIONS. **Dunagin, Percy E. Jr.; Hershman, Jerome M. (Veterans Administration Hospital, Birmingham, Ala. Univ. of Alabama, Birmingham). Proc. Soc. Exp. Biol. Med.; 138: No. 1, 124-9(Oct 1971).**

X irradiation of microsomal particles prepared from pig thyroid homogenates by conventional methods with 100,000 rads before incubation with radioactive leucine reduced protein synthesis as much as 60% of that of a nonirradiated control. The effect of the radiation was most pronounced at early incubation times (15 to 30 min) and at low concentrations of the supernatant fraction. β-Mercaptoethanol, which was necessary for protein synthesis, reduced the amount of x-ray damage to protein synthesis considerably when added before x-irradiation, but had minimal effect when added after x-irradiation. (auth)

6974 RELATIVE HAZARDS FOR INHALED ^{95}Zr AND ^{95}Nb PARTICLES FORMED UNDER VARIOUS THERMAL CONDITIONS. **Thomas, R. G.; Walker, Sharon A.; McClellan, R. O. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Contract AT(29-2)-1013. Proc. Soc. Exp. Biol. Med.; 138: No. 1, 228-34(Oct 1971).**

Aerosols containing ^{95}Zr and ^{95}Nb at near-equilibrium were produced at 100, 250, 600, and 1100° to give particles of four different chemical compositions. When inhaled by mice, a differential metabolism of the radionuclides was sometimes observed, dependent upon the temperature of formation. At the two highest temperatures, the deposited particles were retained tenaciously in the lung and maintained the starting ^{95}Zr–^{95}Nb ratio of ~1.9. At 100°, the radionuclides were translocated from lung to skeleton with a ratio of ~1.3, indicative of an excess burden of ^{95}Zr. At 250° the pattern was similar but less pronounced. The differential patterns of retention resulted in significant differences in radiation dose pattern; at the lowest temperature the highest radiation doses were received by skeleton, lung, and liver, while at the higher temperatures the radiation dose was delivered almost exclusively to lung. (auth)

6975 EFFECTS OF d-PENICILLAMINE AND N-ACETYL-d,l-PENICILLAMINE TREATMENT ON DISTRIBUTION OF

INORGANIC AND CHLORMERODRIN MERCURY IN RATS. Kawin, B.; Winters, E. E. (Veterans Administration Hospital, Washington, D. C.). J. Nucl. Biol. Med.; 14: No. 4, 145-9 (Oct-Dec 1970).

Effects of simultaneous treatment with the sulfhydryl compounds, d-penicillamine (P) and N-acetyl-d, l-penicillamine (AP) on 24-hr retention of radiomercury in rat organs and blood following its administration as inorganic ^{203}Hg (Hg^{2+}) or ^{207}Hg-labeled chlormerodrin (HgN) were studied and compared. The major organ of retention was kidney, where about 16 and 38% of the administered doses of Hg^{2+} and HgN, respectively, were found. The P or AP treatments both decreased retention of HgN in kidney by from 17 to 21% of the administered dose. However, neither P nor AP had statistically significant effects to decrease kidney retention of Hg^{2+}. Small responses to these treatments were observed in other organs where HgN concentrations were low. No effects due to interaction between any combination of the treatments were observed. Possible relations of dose level and dosing time for P and AP treatment in renal or cerebral scintigraphic diagnostic procedures were discussed briefly. (auth)

Radiation Effects

Refer also to abstracts 6593, 7117, and 7130.

6976 SELECTIVE EXTRACTION OF HISTONES FROM NORMAL AND IRRADIATED CALF LYMPH-NODES. Bartkowiak, J.; Klyszejko-Stefanowicz, L.; Wierzbicki, R.; Zablocka, E. (Univ., Lodz, Poland). Int. J. Radiat. Biol.; 20: No. 2, 173-6(1971).

Changes were observed in the differing fractions of histones extracted from normal calf lymph-nodes and from those exposed to x radiation doses of 145.6, 291.2, or 1040 rads. (Extraction was by Johns' methods 1 and 11). There was a loss of about 80% of the F26 fraction in irradiated tissues. The amount of total histone extracted from the irradiated tissues was considerably lower than that obtained as a sum of histone fractions from the same material. The relative decrease in yield was in both cases greater at the lower doses of radiation. This effect was assumed to be due to some dissociation of the histone-DNA complex, detached proteins not being extracted in the case of the total histones. (UK)

6977 HARMFUL EFFECTS OF AN IRRADIATED CELL CULTURE MEDIUM. Szumiel, I.; Ziemba-Zak, B.; Rosiek, O.; Sablinski, J.; Beer, J. Z. (Inst. of Nuclear Research, Warsaw). Int. J. Radiat. Biol.; 20: No. 2, 153-61(1971).

The Fischer medium used for growing L5178Y–S cells, after x-irradiation, exerted on these cells effects similar to those produced by irradiation of the whole cultures. In particular, growth inhibition, decrease of viability, cloning efficiency and of mitotic index were observed. Growth delay caused by irradiation of the medium with 10,000 rads was comparable to that caused by irradiation of the cell culture with 200 rads. Mitotic index under these conditions dropped from 2.5 to 0.4 percent within 1 hour after placing the cells in the irradiated medium. Viability reached a minimum of ca. 25 percent after 48 hours of growth in the irradiated medium. Harmful components of the irradiated medium were labile. Storage of the medium at 37°C for 48 hours led to almost complete restoration of the normal ability to support the growth of L5178Y–S cells. Part of the harmful properties was lost in a short time, e.g. 10 min incubation was sufficient to produce a significant restorative effect. (UK)

6978 ASSOCIATION FOR RADIATION RESEARCH AND THE NETHERLANDS RADIOBIOLOGICAL SOCIETY. Joint Meeting Held at Oxford, England, April 16–17, 1971. Int. J. Radiat. Biol.; 20: No. 2, 181-97(1971). (CONF-710442–(Absts.)).

Abstracts of 39 papers, of which 34 are in NSA scope, are given. (UK)

6979 EFFECTS OF ULTRAVIOLET LIGHT ON RIBONUCLEIC ACID AND PROLINE METABOLISM IN RELATION TO AUXIN-INDUCED GROWTH OF AVENA COLEOPTILE SECTIONS. Wang, Hsiao-chen. University Park, Pa.; Pennsylvania State Univ. (1970). 107p. University Microfilms Order No. 71-21,818.

Thesis.

The effect of uv light on RNA and proline metabolism was studied in relation to auxin-induced cell elongation of Avena coleoptile sections. An action spectrum of the dose of monochromatic uv light necessary to inhibit cell elongation by 50% indicated a maximum at 260 nm and a shoulder at 280 nm. Therefore, a nucleoprotein may be implicated as the photoreceptor leading to inhibition. The total amount of ribonucleic acid in the sections remained constant during incubation with or without prior uv exposure. The applicability of the phenol method for RNA isolation was demonstrated by the fractionation of oat coleoptile sections previously labeled with uridine-^{3}H. The base analysis of the RNA was achieved by Dowex-1 (formate) ion exchange column chromatography after alkaline hydrolysis. The oat RNA was characterized by 35% of guanylic acid, 22 to 24% of cytidylic acid, and about 20% of adenylic acid or uridylic acid. No change in base ratio was detected in either non-irradiated control or uv-irradiated sections. The formation of cytidine mononucleotides from uridine-^{3}H was observed in the hydrolysates. The RNA fractionated by sucrose gradient centrifugation exhibited apparent physical changes after uv irradiation. In addition to a greatly reduced or altered light ribosomal RNA peak, an accumulation of heterogeneous soluble RNA was evident 3 hrs after uv irradiation. A remarkable recovery of the light ribosomal RNA peak and a reappearance of the soluble RNA peak was observed at the end of a 6-hr incubation. The uridine-^{3}H incorporation was almost all in the soluble RNA. The incorporation of L-proline-^{14}C into three protein fractions was inhibited by uv. The major trichloroacetic acid-insoluble proteins contained about 60 to 80% of the proline-^{14}C of the cells, and 50% of the hydroxyproline-^{14}C. The minor TCA-soluble non-dialyzing proteins had less than 10% of the total bound proline-^{14}C but 20 to 30% of the hydroxyproline-^{14}C. The wall fractions contained 20 to 35% of the hydroxyproline-^{14}C and 15 to 30% of the proline-^{14}C. The highest ratio of the hydroxyproline-^{14}C to proline-^{14}C was detected in the TCA-soluble non-dialyzing protein (0.45) rather than in the wall fractions (0.1 to 0.2), whereas the major TCA-insoluble proteins were lowest (0.07). The inhibition by uv light was most severe on the incorporation of proline-^{14}C into the wall fraction. Recovery from the uv-inhibited incorporation of proline into either proline or hydroxyproline was observed in all three protein fractions with the single exception of hydroxyproline into the cell wall fraction. In a pulse-chase experiment, the apparent transfer of labeled proline from the major TCA-insoluble proteins to the wall was completely inhibited by uv during the chase period. Transfer of hydroxyproline from the TCA-insoluble fractions to the wall was noted during the chase period following uv treatment but it was severely inhibited. Very small changes were indicated in the TCA-soluble non-dialyzing proteins during the chase period. The findings of the earlier inhibition and later recovery were consistently demonstrated in both RNA and proline metabolism after uv irradiation. Nevertheless, such a cellular repair process could not overcome the uv inhibition of the auxin-induced elongation of Avena coleptile sections. (Diss. Abstr. Int., B)

6980 INVESTIGATION OF NUCLEASE ACTIVITY IN E. COLI K12 (λ) AS AFFECTED BY ULTRAVIOLET AND IONIZING IRRADIATION. Drozhennikov, V. A.; Guberniev, M. A.; Rybakov, N. I.; Mashinskaya, T. E. (Scientific-Research Lab. of Experimental Immunobiology, Moscow). Biokhimiya; 36: No. 5, 883-8(Sep-Oct 1971). (In Russian).

Ultraviolet radiation and high energy protons cause maximal induction of vegetative phage but do not affect the activity of endonuclease I or exonuclease III in Escherichia coli K 12 (λ). The activity of exonuclease specific for phage λ is correlated with the degree of vegetative phage induction and reaches maximal values at the time of lysis of irradiated cells. After irradiation with uv light and high energy protons the graphs of lethal effects and phage induction versus radiation dose differ in shape. (auth)

6981 PULSE-RADIOLYSIS STUDY OF HUMAN BLOOD PLASMA. Cercek, Lea; Cercek, B.; Keene, J. P. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Int. J. Radiat. Biol.; 20: No. 1, 1-6(1971).

The technique of pulse radiolysis was used to study the transient products of e^-_{aq} and of OH radical reactions in human blood plasma. The half-life for the decay of e^-_{aq} was $(4.5 \pm 0.4) \times 10^{-8}$ sec and that for the decay of OH radicals $(8.3 \pm 0.7) \times 10^{-10}$ sec. Thirty-five per cent of e^-_{aq} yielded the cystine disulphide anion-radical. The yield and the optical absorption spectrum of the hydrated electron, e^-_{aq}, was the same as that in pure water. (auth)

6982 RADIATION EFFECTS IN ISOLATED DNA AND THEIR FUNCTIONAL CONSEQUENCES. XIV. THE INHIBITORY EFFECT OF RADIATION INDUCED BINDING SITES FOR IN VITRO RNA-SYNTHESIS ON PURIFIED DNA (BACILUS SUBTILIS). Leistner, W.; Pitra, Ch. (Forschungszentrum fuer Molekularbiologie und Medizin, Berlin). Stud. Biophys.; 27: No. 1, 37-45(1971). (In German).

The law of mass action is used to describe the dependence of RNA synthesis in vitro on the polymerase concentration in mixtures of unirradiated and synthesis-inactive irradiated DNA. This leads to the following results: Irradiation of DNA with roentgen-radiation (100 Krad) induces about 1.6 new binding sites per natural one; the polymerase affinity of radiation induced binding sites is about 20 times stronger than that of natural ones. It is suggested that the radiation-induced binding sites are 5'-OH-end groups of radiation-induced single-strand breaks. (auth)

6983 RADIATION EFFECTS IN ISOLATED DNA AND THEIR FUNCTIONAL CONSEQUENCES. XVI. ISOLATION OF DNA FROM BACILLUS SUBTILIS AND EXAMINATION OF THE IRRADIATION TECHNIQUE FOR LIGHT NUCLEI. Hartwig, M.; Koerner, I. J. (Forschungszentrum fuer Molekularbiologie und Medizin, Berlin). Stud. Biophys.; 27: No. 1, 53-60(1971). (In German).

DNA from B. subtilis in aqueous solution (concentration = 150 μg/ml, average molecular weight M_w = 20 Mill. D) was not degraded mechanically in a device for the irradiation of biological materials with light nuclei in which a fluid beam is conducted from a capillary through the corpuscule beam of the cyclotron if the diameter of the capillary was $\leq$170 μm and the total flow was $\leq$0.1 cm^{3}sec^{-1}. (auth)

6984 RADIATION EFFECTS IN ISOLATED DNA AND THEIR FUNCTIONAL CONSEQUENCES. XVII. STRAND BREAKS IN DNA OF BACILLUS SUBTILIS IRRADIATED WITH LIGHT NUCLEI. Hartwig, M. (Forschungszentrum fuer Molekularbiologie und Medizin, Berlin). Stud. Biophys.; 27: No. 1, 61-66(1971). (In German).

After irradiation of DNA from Bacillus subtilis in aqueous solution at a concentration of 150 μg/ml viscometric investigations have been used to estimate medium values of breaks in the double- and single-strands of the DNA molecule. In comparison with x-irradiation ($\overline{\text{LET}}$ = 0.45 keV/μm) the break efficiency with deuterons (LET = 7 keV/μm) and α-irradiation (LET = 32 keV/μm) is reduced for single-strand breaks to 37 and 13%, for double-strand breaks to 81 and 41%. Their ratio is reduced to 46 and 32%. The changes of the break efficiency with the LET of irradiation are discussed. (auth)

6985 RADIATION EFFECTS IN ISOLATED DNA AND THEIR FUNCTIONAL CONSEQUENCES. XIII. ON THE VISCOMETRIC MELTING BEHAVIOUR OF IRRADIATED DNA. Hartwig, M. (Forschungszentrum fuer Molekularbiologie und Medizin, Berlin). Stud. Biophys.; 27: No. 1, 29-36(1971). (In German).

The viscometric melting behavior of calf thymus DNA was investigated after x-irradiation in aqueous solution. The reduction of the viscometric Tm-value was up to 10 krad proportional to the dose of irradiation. The principal reason for changes in the melting profiles is single-strand breaks. (auth)

6986 RADIATION EFFECTS IN ISOLATED DNA AND THEIR FUNCTIONAL CONSEQUENCES. XI. N A MODEL ABOUT INFLUENCE OF RADIATION INDUCED ALTERATIONS IN DNA ON TRANSFORMING ACTIVITY: DISCUSSION AND APPLICATION TO EXPERIMENTS. Guenther, K.; Grunow, R. (Forschungszentrum fuer Molekularbiologie und Medizin, Berlin). Stud. Biophys.; 27: No. 1, 13-20(1971). (In German).

In two previous publications the model was developed and a formula describing the dependence of the transformation rate of single and double transformants on dose was derived from it. This formula is now discussed and is used for evaluation of an appropriate x-ray experiment. Thus the usefulness of the model and its use for quantitative interpretation of dose-effect-relations is demonstrated and it is concluded that about $^2/_3$ of the inactivation is due to base alterations in the transforming DNA and only a certain genetically fixed region around the markers is sensitive to base alterations. (auth)

6987 RADIATION EFFECTS IN ISOLATED DNA AND THEIR FUNCTIONAL CONSEQUENCES. X. MATHEMATICAL EVALUATION OF A MODEL ABOUT INFLUENCE OF RADIATION INDUCED ALTERATIONS IN DNA ON TRANSFORMING ACTIVITY. Guenther, K.; Grunow, R. (Forschungszentrum fuer Molekularbiologie und Medizin, Berlin). Stud. Biophys.; 27: No. 1, 1-12(1971). (In German).

The model developed in a preceding paper in axiomatic form is now examined mathematically. For simplicity some mathematical approximations and special assumptions within the framework of the model are used by choice. In this way depending on the level of approximation several formulas describing the dependence of the transformation rate on dose for single and double transformants are derived. (auth)

6988 FRACTIONATION AND ANALYSIS OF GAMMA-IRRADIATED LYSOZYME. Marciani, Dante Juan. Boulder, Colo.; Univ. of Colorado (1970). 174p. University Microfilms Order No. 71-21,609.

Thesis.

The chemical and conformational properties of whole and fractionated lysozyme irradiated in the dry solid state by ^{137}Cs γ rays were studied by a variety of procedures. The results were used to extend our understanding of the basic mechanisms by which enzymes are inactivated by radiation. Irradiated lysozyme (26 Mrad) was fractionated by salting out with 0.1 N acetic acid–1 M NaCl. The salt insoluble fraction, F-I, accounts for 39% of the irradiated lysozyme, and the salt soluble fraction, F-II, the remainder. Chromatography of F-I on Bio-Gel P-60 shows components with hydrodynamic volumes up to 10 times the volume corresponding to native lysozyme. Sodium dodecyl sulfate polyacrylamide gel electrophoresis indicates the presence of 13% of polymers that are formed by integral numbers of lysozyme monomers. The relation between the amount of polymer and degree of polymerization is exponential, indicating a random process of polymerization. Reduction of irradiated lysozyme with 2-mercaptoethanol and alkylation with iodoacetamide show that polymers are formed by intermolecular disulfide bonds. Polyacrylamide gel electrophoresis of F-I in urea reveals the presence of different monomeric forms that differ from native lysozyme and from each other in charge, size, and/or shape. Difference spectra of F-I in 0.1 N versus 1 N acetic acid show that most of the increase in hydrodynamic volume is due to the unfolding of damaged molecules. Difference spectra of F-I components versus native lysozyme in 5.4 M guanidine hydrochloride do not show significant destruction of tyrosyl residues but indicate that tryptophyl residues are destroyed by γ rays. It is suggested that as a result of destruction of the hydrophobic tryptophyl residues, the folding of damaged molecules is different from that of native lysozyme. The alterated conformation allows formation of intermolecular disulfide bonds, probably via a free radical process initiated by cystinyl radicals from solid irradiated lysozyme. F-I fraction shows carbonyl groups, however, no chain breaks of the main polypeptide chain were observed as might be expected from Garrison's theory of carbonyl formation in peptides. An increase in ammonia was observed for F-I components that is more significant in fractions subjected to more fractionation steps, indicating a decomposition of damaged groups. The specific lytic activity of F-I on cells of M. lysodeikticus was 10% of the activity of native lysozyme. The damaged enzyme is inhibited by the substrate at low and high concentrations of substrate, indicating alterations of distribution of electric charges on the surface of the protein molecule. Difference spectra of the enzyme-substrate complexes between F-I components and the artificial substrate, glycol chitin, show a decrease in the capacity of the enzyme to bind the substrate and formation of nonproductive complexes. The destruction of enzyme activity can be a result of the conformational damage and of the destruction of tryptophyl residues that play an important role in the binding of the substrate to the active site of lysozyme. The salt soluble fraction, F-II, does not show a significant increase in hydrodynamic volume, and sodium dodecyl sulfate polyacrylamide gel electrophoresis shows that F-II is a monomeric fraction. Spectral characteristics of this fraction are very similar to those of native lysozyme. Polyacrylamide gel electrophoresis of F-II in urea shows the presence of a main component with characteristics similar to native lysozyme and other small components differing in charge and size. Chromatography on Bio-Rex 70 of whole irradiated lysozyme shows that a large part of F-II molecules are damaged since only 28% of the whole irradiated lysozyme elutes in a position comparable to native lysozyme, whereas the F-II fraction accounts for 61% of the whole irradiated lysozyme. The enzyme specific activity of F-II is 86% of native lysozyme. Difference spectra of the complex between F-II and glycol chitin show the same characteristics observed for the native lysozyme complex, but only 85% as much complex is formed. The loss of enzymatic activity of F-II must be caused by small alterations of the protein structure that do not cause significant alterations of the macromolecular properties. Heavily damaged molecules of irradiated lysozyme tend to aggregate, especially at high ionic strength or high pH values. This aggregation is delayed by substrates, indicating an important role for tryptophyl groups in the aggregation. Perturbation difference spectra studies of irradiated lysozyme show that tryptophyl groups are removed from the contact with the solvent, supporting the suggestion that at high ionic strength or pH, aggregation involves some of the exposed tryptophyl residues. (Diss. Abstr. Int., B)

6989 INFLUENCE OF THE POLYMERIZATION TIME ON THE SOLUBILIZATION OF AN IRRADIATED NATIVE COLLAGEN GEL. Van Caneghem, P.; Lapiere, C. M. (Univ., Liege). Compt. Rend. Soc. Biol.; 164: No. 12, 2671-5(1970). (In French).

Irradiation of native collagen in solution (sol) or in polymer form (gel) slows down the solubilization at 0°C of a gel formed by incubation at 37°C. The delay in clarification is not affected by the length of the incubation time at 37°C before irradiation but increases when this is prolonged after irradiation, for samples irradiated in either the gel or the sol state. The observed effect of x rays is much more pronounced when it is measured on the depolymerization of a collagen previously subjected to a polymerization-depolymerization cycle that reduces the slow component of the second depolymerization. X rays thus seem mainly to increase the formation of bonds that form slowly during polymerization and are dissociated during depolymerization. (France)

6990 FORMATION AND DISAPPEARANCE OF PROPANEDIAL IN IRRADIATED STARCH. Rostan Woodhouse, Denise; Berger, Gerard; Saint-Lebe, Louis (CEN de Cadarache, Saint-Paul-les-Durance, France). Compt. Rend., Ser. D; 273: No. 12, 1064-7(20 Sep 1971). (In French).

The formation of propanedial in irradiated starch is studied as a function of the dose rate and presence of sulfurous anhydride. The reasons why this aldehyde changes during storage were investigated. (France)

6991 RADIATION EFFECTS IN ISOLATED DNA AND THEIR FUNCTIONAL CONSEQUENCES. XVIII. THE ACTION OF DEUTERONS AND α-PARTICLES ON THE TEMPLATE-FUNCTION FROM BACILLUS SUBTILIS DNA. Pitra, Ch.; Malz, W. (Forschungszentrum fuer Molekularbiologie und Medizin, Berlin). Stud. Biophys.; 27: No. 1, 67-72(1971). (In German).

Purified DNA of Bacillus subtilis was irradiated in $^1/_{10}$ SSC-buffer with x rays, deuterons and α-particles and in the in vitro RNA-synthesis-system the template-activity examined. The relative biological effectiveness is for deuterons: 0.86 and for α particles: 0.4. The possible reasons for the different effectivity of applied radiation quantity is discussed. (auth)

6992 DNA-MATRIX DISTURBANCE AND RADIATION INJURY TO PLANTS. Golikova, O. P.; Grodzinskii, D. M. (Inst. of Plant Physiology, Kiev). Dokl. Akad. Nauk. SSSR; 198: No. 5, 1207-10(11 Jun 1971). (In Russian).

Experiments were conducted on DNA taken from irradiated and non-irradiated two-day old roots of pea seedlings in order to study radiation injury to plants. Radiation doses were administered as 5, 10, and 25 krad from a ^{60}Co γ source, and the nucleic acids were separated three hr after exposure. Using ^{32}P-labelled orthophosphate as a radioactive precursor of RNA, it was found that the percentage of hybridization of RNA from non-irradiated roots to the DNA matrix was the same as for the irradiated roots. The effects of the various radiation doses are discussed. (K.S.W.)

6993 RADIATION INJURY OF THE RENATURATION CAPACITY OF DNA INDUCED BY THE ACTION OF PROTONS, HEAVY IONS, AND GAMMA RAYS. Marinova, Ts. I.; Petrova, S. N.; Govorun, R. D.; (and others). Rentgenol. Radiol.; 10: No. 1, 1-7(1971). (In Bulgarian).

The renaturation capacity of DNA isolated from Escherichia coli B was determined following irradiation with γ rays, heavy ions, and protons. Decreases in the renaturation capacity depended on the DNA concentration and the radiation dose. Proton doses of 50 and 60 Krads delivered at 2 rads/sec did not reduce the renaturation capacity of solid denatured DNA, while 80 Krads delivered at the same dose rate reduced it to 55%. (E.R.B.)

6994 EFFECT OF γ RAYS ON COLLAGEN. 3. Strakhov, I. P.; Golovteeva, A. A.; Balashov, Yu. P. Izv. Vyssh. Ucheb. Zaved., Tekhnol. Legk. Prom.; No. 2, 82-4(1971). (In Russian).

Samples of dry collagen and collagen solutions were ^{60}Co γ-irradiated and the molecular weights of the segments were calculated according to P. J. Flory and J. Rehner, Jr. (1943). When the collagen solutions were irradiated, the molecular weights of the segments were 3.56×10^5, 2.33×10^5, 2.20×10^5, and 1.14×10^5 at doses of 0, 10^3, 10^4, and 10^5 rads respectively. When the samples of dry collagen were irradiated, the molecular weights of the segments decreased with increasing dose from 3.20×10^5 at 0 rads (control) to 2.00×10^5 at 10^5 rads. At higher doses, the molecular weights of the segments increased up to 4.56×10^5 at 10^7 rads. (E.R.B.)

6995 RADIATION EFFECTS IN ISOLATED DNA AND THEIR FUNCTIONAL CONSEQUENCES. XII. ON INACTIVATION OF TRANSFORMING ACTIVITY OF BACILLUS SUBTILIS-DNA AFTER IRRADIATION WITH LOW DOSES. Grunow, R.; Guenther, K. (Forschungszentrum fuer Molekularbiologie und Medizin, Berlin). Stud. Biophys.; 27: No. 1, 21-8(1971). (In German).

Bacillus subtilis DNA was x-irradiated with doses up to 2 krads. Relative transforming activities (=TA, native DNA) and relative residual transforming activities (=RTA, thermically denatured DNA) were investigated. With increasing doses RTA decreased more rapidly than TA. The differences between them were interpreted as consequences of different action of single strand breaks in the irradiated DNA. A hypothesis for the mechanism is discussed. This hypothesis explains the differences by existence of repair of a certain number of single strand breaks in TA, while this repair in RTA is not possible because regions of single strands in thermal denaturation are lost. (auth)

6996 PERTURBATIONS IN PRECURSOR INCORPORATION INTO DNA OF X-IRRADIATED HeLa S3 CELLS. Weiss, Barbara G. (Washington Univ., St. Louis). Radiat. Res.; 48: No. 1, 128-45(Oct 1971).

The inhibition of precursor incorporation into DNA by ionizing radiations in HeLa S3 cells is a time-dependent phenomenon, maximum inhibition being achieved 1 to 3 hrs after irradiation with doses of 400 to 2000 rads. The shape of the dose-response curve for incorporation of ^{14}C-thymidine over a short interval of time is therefore strongly dependent on the time at which incorporation is measured. The phenomenon may be further influenced by medium replacement following irradiation, which dampens the inhibition. The kinetics of depression are identical for random and synchronous populations in the S phase at the time of exposure. Pool changes do not seem to play an important role in the fluctuations observed. HeLa cells irradiated in S do not show a compensatory acceleration of DNA synthesis following the inhibition induced by x rays: rather, they continue to make DNA at a slower rate, but for an extended time. When replication ceases, the incorporation is at least as great as in the controls; in a significant number of experiments the total incorporation of label was approximately 20% greater than the control. Cells in G1 and at the G1/S transition at the time of irradiation also show an extended S period and synthesize a full complement of DNA during the irradiated generation. (auth)

Immunology

Refer also to abstract 7083.

6997 ANTIGENIC CHANGES IN DYSPLASIA AND NEOPLASIA FOLLOWING X-IRRADIATION OF RODENT GASTROINTESTINAL TRACT. de Boer, W. G. R. M.; Cauchi, M. N. (Monash Univ., Melbourne). Pathology; 3: No. 4, 291-6(Oct 1971).

The long term effect of x irradiation on the antigenic constitution of gastrointestinal mucosa of mice and rats has been studied. Loss of gastric-specific, as well as gain of intestinal-specific antigens, have been observed in the stomachs of animals that received 1000 rads in the stomach area. Carcinomas developed in four out of five rats that survived for 18 months after irradiation. (auth)

Ecology

Refer also to abstracts 6514, 6530–6532, 7033, and 7077.

6998 CONTAMINATION OF MICROCOSMUS SP. IN THE PRESENCE OF ^{59}Fe AND MODE OF DECONTAMINATION. Leandri, M.; Battani, N. (Institut d'Hygiene Tropicale et de Medecine Sociale, Marseille). Radioprotection; 4: 311-26(1969). (In French).

Experiments were conducted on the contamination and decontamination of Microcosmus sp., a mollusc, using ^{59}Fe as the radioactive element. It was found that the molluscs accumulated the ^{59}Fe very rapidly from seawater and reached a state of equilibrium after about 20 days. The concentration factors at equilibrium are on the order of 300 to 3,000 for molluscs weighing between 1 and 100 g. A relationship of the type F. c. = 3,000 $[P]^{-0 \cdot 45}$ was obtained where F. c. is the concentration factor and P is the weight of the mollusc. These contamination factors seem to correspond to results estimated from the chemical determination of ^{56}Fe, but in order to evaluate the precision of these determinations it is necessary to note the very great variability of the iron concentration in seawater according to the site and depth and variability in the organisms themselves. These concentration factors do not seem to be influenced by differences in pollution rates or by the ^{56}Fe concentration. An equation is developed to show the relationship of biological decontamination to the initial dose and time. (H.L.W.)

6999 MORTALITY OF ADULT EULACHON (THALEICHTHYS PACIFICUS) SUBJECTED TO SUDDEN INCREASES IN WATER TEMPERATURE. Blahm, Theodore H.; McConnell, Robert J. (National Marine Fisheries Service, Seattle). Northwest Sci.; 45: No. 3, 178-82(Aug 1971).

Tests were conducted in 1968 and 1969 to examine some aspects of the thermal tolerance of adult eulachon (Thaleichthys pacificus). Samples of adult eulachon were subjected to lethal and sublethal temperatures, and their resistance time and survival were recorded. In the 1968 test, fish were held for 1 hr at water temperatures ranging from 10°C (control) to 32°C following an acclimation period at 10°C. In the 1969 test, fish were held for 8 days at water temperatures ranging from 5°C (control) to 29°C following an acclimation period at 10°C. The effects of the elevated temperatures on swimming movements, spawning cycle, and mortality of the fish are recorded and discussed. (E.R.B.)

Genetics and Cytogenetics

Refer also to abstracts 6978, 7110, and 7112.

7000 (IAEA-R-460-F) STUDIES ON THE EFFECT OF NEUTRON IRRADIATION ON SEEDS. PART OF A COORDINATED PROGRAMME OF RESEARCH ON THE USE OF NEUTRONS IN SEED IRRADIATION. Final Report, November 1, 1966–July 31, 1970. Soriano, J. D. (International Atomic Energy Agency, Vienna (Austria)). Oct 1970. 13p. INIS.

The contractor has carried out the chemical and physical dosimetry of the Standard Neutron Irradiation Facility (SNIF) provided by the Agency, according to the procedure recommended by the participants and consultants in this coordinated research program. In addition, the biological monitor (Himalaya barley seeds) has been used and checked by the standardized technique. Following this calibration of the SNIF as a source of fast neutrons relatively free of gamma ray contamination, the contractor has used the facility to study a number of radiobiological phenomena, among them mutation frequency as a function of mutagen, and neutron radiosensitivity and mutation frequency as related to variety in rice. Experiment techniques in all cases were those recommended under the program. Among the eight varieties of rice studied, six were relatively more sensitive to fast neutrons (50% seedling height reduction at about 2.1 kRad), while two were more resistant (LD_{50} at about 2.7 kRad). Seedset also could be used to group the varieties into the same classes. Frequency of anaphase cell aberrations appearing after 2.4 kRad doses also was determined; varieties differed but without clear cut groupings. Hybrid varieties tended to separate as a class when mutation frequency in M_1 panicles was compared with chromosome volume. Intervarietal differences were found in each of the responses to neutron irradiation which were measured, suggesting an influence of genetic factors, though it would seem that difference in chromosome volume does not completely explain the results. (INIS)

7001 (IAEA-R-474-F) STUDIES ON THE EXPERIMENTAL APPLICATION OF RADIOSENSITIVITY IN MUTATION BREEDING. Final Report, November 1, 1966–February 28, 1970. Bai, D. H. (International Atomic Energy Agency, Vienna (Austria)). May 1970. 125p. INIS.

Investigations conducted under the Agency's research contract no. 474 deal with the detailed radiobiological analyses in the economic plants from the Korean flora, representing 18 different families and 47 species. Radiosensitivity characteristics of these families and species were studied with respect to different doses and dose rates of x rays, γ rays, and neutrons, as applied to the different life-cycle stages and tissues, either in single or fractionated dose regimens. As the criteria for the assessment of radiosensitivity, use was made of the radiation effects on seed germination rates, seedling growth, survival frequency and LD_{50} of the plants from irradiated generations, somatic and genetic aberration frequencies in the successive post-irradiation generation, and the induced chromosomal aberrations. Experimental data are presented for the spectrum of radiosensitivity of different plant families as well as for the suitability of particular plant stages (e.g. dry or pre-soaked seeds, early seedlings, older seedling stages) for irradiation operations. In general, the Cruciferae were most radioresistant, followed in the decreasing order by the Graminae, Leguminosae, Cucurbitaceae, Solanaceae, Umbelliferae, Liliaceae, Labiatae, and others. In a particular plant species, the dry dormant seeds are more radioresistant compared to the soaked and germinated seeds. From the observations, it was concluded that very early seedling stages are most sensitive to radiation-induced variability, as studied in a number of plants including the Korean rice variety Calady-40, with respect to radiation dose-effect for mutation induction. Conclusion has been drawn further that the mutational yield is enhanced by dose fractionation as compared to an equivalent single acute dose. The rationale behind this study is to define the optimal combinations of various radiobiological parameters leading to the maximal yield of induced heritable variations (mutations) for selection and applications in plant breeding, with concomitant reduction of undesirable gross damages and dominant lethals that generally lead to the non-perpetuating events. These specific radiobiological parameters were considered by the investigator as the essential prerequisite for increasing the effectiveness of the radiation-mutation-breeding program, particularly for the Korean plants for which no such studies were undertaken before. (INIS)

7002 (IAEA-R-497-F) STUDIES OF THE EFFECT OF NEUTRON IRRADIATION ON SEEDS. PART OF A COORDINATED PROGRAMME OF RESEARCH ON THE USE OF NEUTRONS IN SEED IRRADIATION. Final Report, December 15, 1966–December 14, 1970. Gopal-Ayengar, A. R.; Rao, N. S.; Bhatt, B. Y.; Mistry, K. B.; Joshua, D. C.; Thakare, R. G. (International Atomic Energy Agency, Vienna (Austria)). Jan 1971. 34p. INIS.

Radiobiological studies were carried out using fast neutrons produced in the standard neutron irradiation facility (SNIF) provided as a part of the coordinated program and installed in the APSARA reactor in Trombay. Doses of fast neutrons in the range of 1000 to 2200 rads caused reduction in height of seedlings grown from irradiated barley seeds stored 10 to 84 days after irradiation. Extent of reduction depended on dose and storage period, but averaged about 15%. With neutrons, there occurred a slight decrease in frequency of chromosome deletions with storage, whereas with gamma rays, there was an increase by about two-thirds after 30 days' storage. Radiosensitivity to fast neutrons and to gamma rays was assessed using seedling height reduction as the criterion for comparison. On the basis of D_{50} values (i.e., dose which causes 50% reduction), RBE values for 15 crop species and varieties varied from 6.8 to 36.0. RBE values for mutations considered to be related to the specific character short-culm in rice were determined using the following criteria: seedling height reduction (RBE = 10.7), chromosome interchange frequency (7.2), seed sterility (12.3), chlorophyll mutation frequency (18.7) and dwarfness (26.0). (INIS)

7003 ANOTHER TWO GENES CONTROLLING MITOTIC INTRAGENIC RECOMBINATION AND RECOVERY FROM UV DAMAGE IN ASPERGILLUS NIDULANS. IV. GENETIC ANALYSIS OF MITOTIC INTRAGENIC RECOMBINANTS FROM uvs$^+$/uvs$^+$, uvsD/uvsD AND uvsE/uvsE DIPLOIDS. Fortuin, J. J. H. (Rijksuniversiteit, Utrecht). Mutat. Res.; 13: No. 2, 137–48(Oct 1971).

This paper presents the results of a genetic analysis of a number of spontaneous mitotic p-aminobenzoic acid-independent recombinants from uvs$^+$/uvs$^+$, uvsD53/uvsD53 and uvsE82/uvsE82 diploids that are heteroallelic at the pabaA locus. Intragenic recombination in each of the three strains is largely nonreciprocal and may usually result from gene conversion. Gene conversion may be strongly correlated with crossing-over between outside markers in the uvsE82/uvsE82 diploid. Conversion shows no polarity in the uvs$^+$/uvs$^+$ diploid; in the uvsE82/uvsE82 diploid there is almost no conversion of the distal pabaA allele; the proximal allele probably converts more often in uvsE82/uvsE82 but this is obscured by the high back-mutation rate of the proximal allele. Whether there is any polarity of gene conversion in the uvsD53/uvsD53 diploid cannot be inferred from the results. More than half of the recombinants from the uvsD53/uvsD53 diploid have an apparently complex origin and may have arisen by double exchanges or by second-order recombination. No such complex recombinants have arisen from the uvsE82/uvsE82 diploid and their frequency among recombinants from the uvs$^+$/uvs$^+$ strain is 16%. The frequency of appearance of these complex recombinants in our strains seems to be correlated with the frequency of intragenic recombination in the particular strains, as influenced by the uvs allele they bear. (auth)

7004 ANOTHER TWO GENES CONTROLLING MITOTIC INTRAGENIC RECOMBINATION AND RECOVERY FROM UV DAMAGE IN ASPERGILLUS NIDULANS. III. PHOTOREACTIVATION OF UV DAMAGE IN uvsD AND uvsE MUTANTS. Fortuin, J. J. H. (Rijksuniversiteit, Utrecht). Mutat. Res.; 13: No. 2, 131-6(Oct 1971).

Photoreactivation of uv damage in growing uvs$^+$, uvsD53 and uvsE82 conidia of Aspergillus nidulans is examined. The results indicate that uvs$^+$ and uvsE82 conidia immediately start to lose photoreactivable lesions following incubation in the dark, but that uvsD53 conidia retain these lesions for at least several hours. The observations are interpreted as indicating that uvs$^+$ and uvsE82 conidia are excision-efficient but that uvsD53 is defective in excision repair. (auth)

7005 KINETICS OF REJOINING OF SINGLE-STRAND BREAKS INDUCED BY IONIZING RADIATION IN DNA OF HUMAN LYMPHOCYTES. Donlon, T.; Norman, A. (Univ. of California, Los Angeles). Mutat. Res.; 13: No. 2, 97-107(Oct 1971).

The kinetics of repair of single-strand breaks induced by 6-MeV electrons in DNA of human lymphocytes was studied using sedimentation-velocity analysis of molecular weights. The rate of repair was found to be rapid initially and essentially constant for the first 20–30 min of incubation at 37°; it then declined markedly. For the rapid initial process the activation energy over the temperature range of 22–37° was 19.1 ± 0.4 kcal/mole, the temperature at maximum rate was about 40°, and the Michaelis–Menten constant, estimated from the rate at $V_{max}/2$, was approx. 20 krad. These results are similar to those characterizing the rate-limiting step for unscheduled DNA synthesis stimulated by X-rays. Moreover, the number of breaks per rad and the maximum rate of rejoining of single-strand breaks found in this study are similar respectively to the number of lesions per rad and the maximum rate of incorporation of nucleotides per cell found in studies of unscheduled DNA synthesis. It seems likely, therefore, that the repair of single-strand breaks and the incorporation of nucleotides in unscheduled DNA synthesis share the same rate-limiting enzymatic step. (auth)

7006 MUTATION TO 8-AZAGUANINE RESISTANCE INDUCED BY γ-RADIATION IN A CHINESE HAMSTER CELL LINE. Arlett, C. F.; Potter, Janie (Atomic Energy Research Establishment, Harwell, Eng.). Mutat. Res.; 13: No. 1, 59–65(Sep 1971).

Mutations for resistance to 8-azaguanine (7.5 μg/ml) induced by γ-radiation, were examined for evidence of repair of premutational lesions. The mutation induction response curve is biphasic; more mutants were induced at higher than at lower doses. The cumulative nature of the response curve might have origin in repair mechanisms and this assumption was supported by the demonstration of a sparing effect on mutation in split-dose experiments. Using synchronised populations of cells responses for both survival and mutation was shown to be dependent on the cell cycle stage. G2 phase cells were more mutable than GI or S phase cells. It is proposed that the difference might have origin either in differential repair or in some time-dependent mechanism. (auth)

7007 COMPARATIVE STUDIES OF THE EFFECT OF X-RAYS AND I,3-PROPANEDIOLDIMETHANESULFONATE ON THE MOSQUITO CULEX PIPIENS L. Jost, E.; Amirkhanian, J. D. (Johannes-Gutenberg Univ., Mainz). Mutat. Res.; 13: No. 1, 49–57(Sep 1971).

The toxicity of 1,3-propanedioldimethanesulfonate (PMS) was tested in Culex pipiens, strain Hamburg, as a preliminary to the design of further experiments on the production of translocations in mosquitoes which could be used for eradication experiments. Doses between $2.15 \cdot 10^{-3}$ μmole/fly and $1.7 \cdot 10^{-1}$ μmole/fly were used in the experiment and compared with x-rays with respect to dominant lethality and the induction of translocations. Similar to the effect of x-rays, PMS produced dominant lethal mutations as well as semisterility when mature sperm of Culex pipiens was exposed to different concentrations of the chemical. There was a conspicuous increase in F_1 lethals from 10% at $1.7 \cdot 10^{-2}$ μmole/fly to 100% at about 2.10^{-1} μmole/fly. 3–4% semisterility detected in the F_2 generation was due to translocations or pericentric inversions; this was independent of the dose of the chemical used from $1.7 \cdot 10^{-2}$ μmole/fly to $5.1 \cdot 10^{-2}$ μmole/fly. Evidence for translocations was obtained from cytological tests of semisterile lines. (auth)

7008 GENETIC RECOMBINATION IN ESCHERICHIA COLI. IV. ISOLATION AND CHARACTERIZATION OF RECOMBINATION-DEFICIENT MUTANTS OF ESCHERICHIA COLI KI2. Storm, P. K.; Hoekstra, W. P. M.; De Haan, P. G.; Verhoef, C. (State Univ., Utrecht). Mutat. Res.; 13: No. 1, 9–17(Sep 1971).

Nineteen independent recombination-deficient mutants were isolated. Seven carried mutations that mapped near or in the recB and recC genes between thyA and argA. 10 mutants carried mutations cotransducible with pheA and exhibited no complementation with recA in temporary zygotic diploids. Two new genes controlling recombination have been identified. Strain PC 0297 carried a mutation designated recG162, and was uv- and x-ray-sensitive. It was located between pyrE and ilvA. Strain PC1250 was only slightly uv-sensitive, was x-ray-resistant and carried the mutation designated recH166 which was located between pheA and cysQ. (auth)

7009 RecA$^+$-DEPENDENT MUTAGENESIS OCCURRING BEFORE DNA REPLICATION IN UV- AND γ-IRRADIATED ESCHERICHIA COLI. Bridges, B. A.; Mottershead, R. (Univ. of Sussex, Brighton, Eng.). Mutat. Res.; 13: No. 1, 1–8(Sep 1971).

Loss of photoreversibility of mutations to streptomycin resistance occurred in the absence of DNA replication in a uvr$^+$ but not in a uvrA strain of Escherichia coli WP2 after exposure to uv, suggesting that excision may be the first step in the mutational process at this locus. A similar result was obtained with bacteria grown in a chemostat under conditions where most of the genes were unreplicated within a given cell. Such bacteria were also almost as mutable by γ-radiation as logarithmic-phase bacteria with several genomes. It is concluded that mutation induction after uv (in uvr$^+$ strains) or after γ-radiation, at least at some loci, can occur before the first DNA replication and need not involve recombination between homologous chromosomes, despite a dependence upon the recA$^+$ allele. (auth)

7010 LONG-TERM EFFECT OF RADIATION ON CHROMOSOMES OF CULTURED HUMAN FIBROBLASTS. Minkler, Jason L.; Piluso, Dolores; Gofman, John W.; Tandy, Robert K. (Univ. of California, Livermore). Mutat. Res.; 13: No. 1, 67–75(Sep 1971).

Six monolayer fibroblast tissue cultures of different human origin were used for this study. Portions of each culture were ^{60}Co-irradiated with varying doses of up to 500 rad at various times in their life history. The cultures were then maintained and observed for at least 10 months along with their normal unirradiated controls for long-term changes in their chromosome composition. At least one of the irradiated fractions of each of the six primary cultures ultimately became pseudodiploid with one or more conspicuous markers, while the corresponding unirradiated control cultures remained diploid. In those cultures which provided favorable material for sequential observations after marker appearance, the pseudodiploid cells with the marker chromosomes soon prevailed in the culture. None of the irradiated cultures showed signs of alteration into established cell lines as of this writing. They all appear to have stopped rapid growth at approximately the same time as their normal diploid controls. (auth)

7011 COMPLEMENTATION AND GENETIC RECOMBINATION IN CANDIDA LIPOLYTICA. Bassel, John; Warfel, Jean; Mortimer, Robert (Univ. of California, Berkeley). J. Bacteriol.; 108: No. 1, 609–11(Oct 1971).

Nutritional requirements were introduced into wild-type, heterothallic strains of Candida lipolytica by exposing the cells to x rays. Complementing hybrids were recovered from mixtures of the auxotrophic strains, and genetic recombination was observed in individually isolated ascospores from the hybrid strains. (auth)

7012 RELATIVE BIOLOGICAL EFFECTIVENESS OF 14 MeV NEUTRONS FOR INDUCING DOMINANT LETHALS IN MATURE SPERM OF THE SILKWORM: A COMPARISON OF THE RBE FOR DOMINANT LETHALS AND SPECIFIC-LOCUS MUTATIONS. Murakami, Akio (National Inst. of Genetics, Misima, Japan). Jap. J. Genet.; 46: No. 2, 67–74(May 1971).

Comparisons of RBE values of 14 MeV fast neutrons for the induction of dominant lethals and visible recessive mutations in mature sperm of the silkworm were studied. The main conclusions to be drawn from the results presented are that the RBE of fast neutrons for the dominant lethals (RBE: 10.2) is about 2.1 times that of the mosaics (RBE: 4.8), and the RBE for the mosaics is the same or less than that for the complete mutations (RBE: 6.0). Considering these findings and others, it seems that the nature of radiation-induced complete and mosaic mutations at the pe and re loci of the mature sperm of the silkworm, at doses below about 5 kR, could have occurred as a mixture of DNA strand change type mutations and chromosomal type such as deletion and small deficiency, whereas the dominant lethals may correspond to chromosomal changes. (auth)

7013 INHALED OZONE AS A MUTAGEN. II. EFFECT ON THE FREQUENCY OF CHROMOSOME ABERRATIONS OBSERVED IN IRRADIATED CHINESE HAMSTERS. Zelac, R. E.; Cromroy, H. L.; Bloch, W. E. Jr.; Dunavant, B. G.; Bevis, H. A. (Univ. of Florida, Gainesville). Contracts NOO228-68-C-2658; AT(40-1)-3599. Environ. Res.; 4: No. 4, 325–42(Oct 1971).

Exposure-adjusted break frequencies for chromosome aberrations produced in Chinese hamster circulating blood lymphocytes were the quantitative indicator of damage from 5 hours of exposure to x-radiation (118 keV effective, 70 cm FSD, 230 rad) and/or to ozone (0.2 ppM, uv generated). There were two groups of four per treatment plus one group exposed to 330 rad. Radiation produced 5.51×10^{-4} breaks/cell rad for cells withdrawn 2 weeks after exposure, a reasonable value when compared with data from in vivo exposure of human lymphocytes and Chinese hamster bone marrow cells. Animals exposed to the two agents simultaneously exhibited >70% of the total breaks anticipated assuming the expected equal contributions to be additive. Extending to humans, at presently permitted levels, exposure to ozone would be much more detrimental than exposure to radiation. (auth)

7014 SELECTION FOR INCREASED ABDOMINAL BRISTLE NUMBER IN DROSOPHILA MELANOGASTER WITH CONCURRENT IRRADIATION. I. POPULATIONS DERIVED FROM AN

INBRED LINE. Hollingdale, Barbara; Barker, J. S. F. (Univ. of Sydney). Theor. Appl. Genet.; 41: No. 5, 208-15(1971).

Replicate lines, each with one hundred pairs of parents selected at 50% intensity, were derived from an inbred line. For twenty generations three lines were selected without irradiation and five with 1000 R x-rays per generation given to both females and males. After adjustment for level of crowding in the cultures, the final mean was 1.3 bristles higher in females and 1.0 bristles higher in males in the irradiated lines than in the unirradiated lines. In terms of phenotypic standard deviations in each sex in the base population, these total responses were 0.74 and 0.59 respectively. Radiation can induce mutations useful in increasing responses in selection programmes, but the average response attributable to radiation is small, and heterogeneity between replicate lines is to be expected. (auth)

7015 16th SCIENTIFIC REUNION OF THE ITALIAN GENETICS ASSOCIATION, ERICE, ITALY, OCTOBER 15–17, 1970. Atti Ass. Genet. Ital.; 16: 1-96(1971). (In Italian). (CONF-701057–(Absts.)).

English and Italian abstracts of the papers given at the Sixteenth Reunion of the Italian Genetics Association are presented. Two abstracts refering to papers on ultraviolet radiosensitivity of Schizosaccharomyces pombe and mutations in cultured haploid tobacco plants obtained from x-irradiated anthers are within the scope of NSA. (E.R.B.)

7016 ABNORMAL CLONE FORMATION IN BONE MARROW FROM ^{32}P-TREATED PATIENTS WITH POLYCYTHAEMIA VERA. Visfeldt, Jakob (Inst. of Pathology, Copenhagen). Acta Pathol. Microbiol. Scand., Sect. A and B; Suppl. No. 215, 49(1970).

Twenty-eight patients with polycythaemia vera divided into 4 groups: untreated, treated without bone marrow fibrosis, treated with bone marrow fibrosis, and treated patients in whom incipient transition into leucaemic phase was suspected. Chromosome analyses revealed in 13 cases clone formation in the bone marrow, comprising 32 to 100 percent of the cells analyzed. Apart from one case the karyotypes of the clones contained 46 chromosomes, in the remaining clone 47 chromosomes were found. The chromosome aberrations in the clones were of the stable types i.e., aberrations which presumably do not interfere mechanically with the mitoses. No clones were found in untreated patients. The three groups of treated patients all included cases with clone formation In most cases the patients had been treated with heavy doses of ^{32}P over long periods of time. Probably the chromosome aberrations are primarily radiation-induced, as a result of ^{32}P therapy. Among the 13 patients with clone formation three have died from acute leucaemia. This raises the question as to whether the clones represent malignant populations. Demonstration of clone formation in the treated polycythaemia vera patients may contribute to elucidating the problems relating to the highly debated, heavily increased incidence of laucaemia following the introduction of ^{32}P therapy in polycythaemia vera. (auth)

7017 GENETIC EFFECT OF X-RAYS AND EMS ON THE ROOT SYSTEM OF WINTER WHEAT. Hanis, M. Genet. Slechteni; 7: No. 3, 185-90(Jul 1971). (In Czech).

After the exposure of the seeds of winter wheat variety "Poros" to a dose of 18,000 R of x-rays or EMS, 725 morphologically unchanged plants were selected at random in the M_2 generation. In the M_3 generation of their offsprings, the number of embryo roots was examined as the quantitative characteristic of the mutations of the root system. In comparison with the unexposed control, the variability of the number of embryo roots increased to a four-fold value, mostly in the negative direction. In about 19% of the offsprings the number of the embryo roots was decreased, in the whole population to 90.8 ± 0.28% of the control, on the average. Similar results were obtained also in the set of 85 mutants from variety "Salzmünder Bartweizen" in the M_7 and M_8 generations. In the set of 41 mutants from variety "Diana I" in the M_8 generation the variability in the number of embryo roots was also increased to a more than two-fold value, in both directions. It was demonstrated that mutagens induced mutation even in the root system. (auth)

Health Physics and Safety

Refer also to abstracts 6768 and 6804.

Radioactive Contamination and Decontamination

Refer also to abstracts 6581, 6735, 6775, 6808, 6974, and 7101.

7018 RADIOACTIVE FALLOUT IN SOIL. Eriksson, Aake (Lantbrukshoegskolan, Uppsala). Grundforbattring; 23: Special Issue No. 5, 23-30(1970). (In Swedish). (CONF-691139–1).

From Soil as Receiver of pesticides, heavy metals, and radioactive substances conference; Stockholm, Sweden (13 Nov 1969).

The deposition of fallout after nuclear weapons tests in 1961 and 1962, and the resulting intake with food and accumulation of ^{90}Sr and ^{137}Cs in the body of man during the following years is given. In the long-term situation, after the cessation of fallout, the amounts of ^{90}Sr and ^{137}Cs deposited in the soil is the only source from which crops can be contaminated. In this situation the characteristics of the soil determine the contamination levels of the crop products within wide limits. A higher ^{90}Sr/Ca-ratio in plants was obtained on soils with low cation exchange capacity and low calcium content than when these characteristics show higher values. A factor of 10 has been observed for cultivated soils. A still larger variation has been found for the root uptake of ^{137}Cs. A factor of 50 has been observed. The ^{137}Cs-uptake was lowest on soils rich in clay and potassium and reached its highest value on organic soils. The different production areas were classified with respect to the expected content of ^{90}Sr and ^{137}Cs in the crops at certain contamination levels of the plough layer. This work showed that the main part of our foods are produced in areas, where they will obtain comparatively low contents of ^{90}Sr and ^{137}Cs after a fallout period. In some economic margin areas, however, the contamination level of the foods can be considerably higher. (Sweden)

7019 CONTAMINATIVE BEHAVIOR OF RADIOACTIVE MATERIALS ON PROTEIN FILM SURFACE. Tashiro, Shingo (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 8: No. 9, 513-19(Sep 1971).

The mechanism of skin contamination with radioactive materials was studied using protein film to simulate the human skin. The protein films were contaminated with $^{35}S(H_2SO_4)$, $^{204}Tl(TlNO_3)$, and $^{147}Pm(PmCl_3)$, and many factors such as soiling time, radioactive concentration, specific activity and acidity of the soiling solutions, and the concentration of coexisting electrolytes were changed to examine their effect. It is concluded that the protein film is a useful material for studying the mechanism of skin contamination with radioactive materials. The contaminative behavior of the different radioisotopes on the film surface was found to reflect their respective properties, and varied accordingly. (auth)

Dosimetry and Monitoring

Refer also to abstracts 6776, 6788, 6834, and 6923.

7020 (BARC/INF–5) A NATIONAL PROGRAMME FOR SAFETY IN THE TARAPUR ENVIRONMENT. (Department of Atomic Energy, Bombay (India)). 1970. 13p. INIS.

The activities of the Environmental Survey Laboratory at the Nuclear Power Station, Tarapur, India, are enumerated. The environmental radioactivity was determined by analyzing samples of sea water, fish, salt, and foodstuffs. Diet surveys were conducted to detect the ingestion of radionuclides in the local population. Measurements of the radioactivity burden of the radiation worker and the local population were carried out. Coastal water movements were studied and will be of great use in the drawing up of future engineering designs. A surveillance program is maintained to detect the progressive build-up of radioactivity in the environment owing to the operation of the power station and to recommend remedial actions before the permissible levels are exceeded. (INIS)

7021 (INMAS/HP–15–70) DOSIMETRY OF INTERNAL EMITTERS. Reddy, A. R. (Institute of Nuclear Medicine and Allied Sciences, Delhi (India)). 1970. 20p. (CONF-701138–2). INIS.

From National symposium on radiation physics; Bombay, India (24 Nov 1970).

A review of the dosimetry of internal emitters is presented. The general formalism of dose estimation is discussed. It is pointed out that, whereas the physical information for dose estimation in a homogeneous target due to a uniform distribution of activity is available in fair detail, the same for non-uniform distribution of activity is still very scanty. Biological data for many radiopharmaceuticals used in nuclear medicine are not complete and are subject to variations. Specific examples of dosimetry of ^{3}He-thymidine in cell biology, dosimetry of iodine isotopes in thyroid investigations, and dosimetry of bone seeking isotopes are discussed to bring out to what extent the unit Rad is valid, the necessity of a new modification factor to the physical dose in explaining the biological effect, and the influence of non-uniformity in activity distribution over the dose rate in case of bone seeking isotopes respectively. (INIS)

7022 RADIATION DOSE AS A FUNCTION OF DENSITY AND BIOLOGICAL HALF-LIFE IN POPULATIONS OF TRIBOLIUM CONFUSUM DUVAL. Kennington, Garth S.; Percival, Donald R. (Univ. of Wyoming, Laramie. Atomic Energy Commission, Idaho Falls, Idaho). Physiol. Zool.; 44: No. 1, 48-57 (Jan 1971).

Techniques are described for labeling the larvae of Tribolium confusum with ^{137}Cs and ^{22}Na. After making initial determinations of radioactivity in the larval population, the larvae were placed, together with thermoluminescent dosimeters, in plastic population vials. Two types of TLD were used, one depending on calcium fluoride : dysprosium and the other on lithium fluoride. Formulas for computing beta and gamma doses were developed and a table is presented to show 48-day radiation doses and corresponding calculated population doses. The doses registered by the TLD increased with population density. Two sources of difference between the exposure from each radionuclide could be demonstrated. One was related to the difference in excretory pattern between the two nuclides and the other was that inherent in the energies of the respective radiations. A discussion is given of these two factors. (H.L.W.)

7023 AMBIENT RADIOACTIVE CONTAMINATION: ATMOSPHERE, WATER, FOOD PRODUCTS. Murillo, Freddie Orbe; Salazar de Ortega, Magdalena. Politecnica (Quito); 1: No. 3, 75-112(1969). (In Spanish).

The results of measurements of the radioactivity in the atmosphere, water, and food products in Quito from June 1967 to December 1967 are reported in graphs and tables. (J.S.R.)

7024 CONCRETE EXAMPLES OF INTEGRAL ABSORBED DOSES. Bercy, A. (Hopital Civil, Chatelet, Belg.). J. Belge Radiol.; 54: No. 4, 515-22(Jul-Aug 1971). (In French).

By means of diagrams and a simple formula, the integral doses absorbed in respect of all the yet known means of radiography (X rays and γ rays) are calculated. The possibility of calculating the integral dosage absorbed during interstitial radiumtherapy is also demonstrated. A few examples are given in proof of the utility of calculating the integral dose absorbed, also in radioprotection. (auth)

7025 RADIATION EFFECTS IN ISOLATED DNA AND THEIR FUNCTIONAL CONSEQUENCES. XV. ON THE TRACK-SEGMENT-METHOD; TECHNIQUES OF IRRADIATION AND DOSIMETRY FOR BIOLOGICAL MATERIAL IN AQUEOUS SOLUTION. Erzgraeber, G.; Eichhorn, K. (Forschungszentrum fuer Molekularbiologie und Medizin, Berlin). Stud. Biophys.; 27: No. 1, 47-52 (1971). (In German).

For irradiation of biological objects with charged particles of different LET an irradiation device is described that consists of two all-glass syringes with nozzles 170 μm in diameter and a penetrated ionization chamber. (auth)

7026 METHODOLOGICAL STUDIES ON A WATER-SILICONE OIL SYSTEM DESIGNED FOR ANALYSIS OF DISPLACEMENTS OF BETA-EMITTING RADIONUCLIDES. Lyttkens, L.; Oestrand, U. (Uppsala Univ.). Acta Soc. Med. Upsal.; 75: No. 3-4, 91-109(1970).

A two-phase system (water-silicone oil) is described, whereby the surface of a membrane (artificial or biological) can be perfused with a radioactive saline. The membrane will hereby be covered by a thin surface film of the perfusion solution. By placing semiconductor detectors a short distance from the membrane surfaces, direct, quantitative measurements of the radioactive contents of the membrane and surface films can be made. The system thus allows utilization of a principle which has been presented earlier, making possible detection of displacements of a radioactive source of the order of magnitude 0.1 to 0.5 μ (depending on the choice of isotope). Studies of the two-phase and detection systems have shown that under certain conditions these have reproducible and stable properties. Measurements of the surface film showed an order of size of 4 μ ($\pm 2\ \mu$). Thus under certain conditions the system would seem to show good prerequisites for studies of ionic tracer movements in membrane systems. The method permits sampling of perfusate from each of the membrane surfaces, facilitating analysis of low-energy isotopes, e.g., ^{3}H and ^{14}C. (auth)

7027 DISTRIBUTION OF RADIATION EXPOSURE WITHIN THE PLANE OF A CIRCULAR LINE SOURCE. Miller, A. L.; Tanaka, M.; Cember, H. (Northwestern Univ., Evanston, Ill.). Health Phys.; 21: No. 4, 602-5(Oct 1971).

The distribution of exposure rates within the plane of a circular source was determined theoretically and the solution verified experimentally using thermoluminescent dosimetric materials. (UK)

7028 HUMAN SPECTROMETRY. MEANS OF DIAGNOSING INTERNAL CONTAMINATION. USE OF THIS METHOD IN THE SERVICE DE SANTE. Frossard, H.; Andrieu, L.; Golhen, A.; Flauder, M.; Poutrain, P. (Service de Sante des Armees, Paris). Rev. Corps Sante Armees; 12: No. 2, 187-200(Apr 1971). (In French).

Human γ-ray spectrometry was used as a method of diagnosing internal contamination. The principle of the γ-ray spectrometer is exposed and the apparatus used described. Two types of installation exist: a heavy type of installation with extensive shielding and an excellent sensitivity, and a lighter type of installation with an inferior sensitivity. Five installations of this type were installed in Paris, the Pacific, and the Sahara during the French nuclear experiments. (auth)

7029 NOTES ON GONADAL ABSORBED DOSES IN ROENTGEN DIAGNOSIS. Torretta, A.; Reis, F.; Pini, M. (Istituto di Radioterapia, Trieste, Italy). Minerva Med. Giuliana; 62: 779-81(25 Feb 1971). (In Italian).

The genetically significant gonad dose calculated in different studies was compared. There was a significant divergence in the doses calculated by different authors. The gonad dose in radiological examination of the thorax was much higher than that of standard radiographic examinations. All x-ray diagnostic examinations in the region of the abdomen gave much higher gonad doses. (J.S.R.)

7030 STANDARDS AND THEIR DISSEMINATION IN THE FIELD OF RADIATION MEASUREMENT. Jennings, W. A. (National Physical Lab., Teddington, Eng.). pp 2-3 of Radiation Dose and Dose Distribution Measurements in the Megarad Range. Slough, Eng.; United Kingdom Panel on Gamma and Electron Irradiation (1971).

From Symposium on gamma and electron irradiation; Teddington, England (6 Jul 1970). See CONF-700659.

A brief account is given of the NPL's work and philosophy in the field of dosimetry, with special reference to standards and calibration services. (UK)

7031 GAMMA RAY DOSE DISTRIBUTIONS IN NON-UNIFORM MATERIALS. Zanelli, G. D. (Univ. of Leeds, Eng.). pp 24-9 of Radiation Dose and Dose Distribution Measurements in the Megarad Range. Slough, Eng.; United Kingdom Panel on Gamma and Electron Irradiation (1971).

From Symposium on gamma and electron irradiation; Teddington, England (6 Jul 1970). See CONF-700659.

Experimental information on dose distribution in heterogeneous materials irradiated with high energy photons is sparse, but in the energy range of one to a few tens MeV non-uniformity in the irradiated material appears not to distort dose or dose rate profiles appreciably, and in many practical cases can result in errors of only 2 to 10%. The zones of greatest importance in this connection are those separating the various body tissues, and the development of transition zone dosimetry and its impact on radiobiology and radiotheraphy are briefly reviewed. Special attention is directed to the bone-tissue problem. With regard to the effect of atomic number, between about 200 keV and 1 MeV the difference in energy absorption between low and high Z materials almost disappears; in this region the Compton effect, which is independent of Z, predominates. Further up the energy scale the atomic number of the absorber again becomes important, since above 1.02 MeV pair production interactions occur, the cross-section for which is a linear function of Z. A brief review is included on experimental work on interface dosimetry with high energy photons, including implications for sterilization of medical equipment and food-stuffs. One important practical point concerns the irradiation of patients on steel treatment couches with ^{60}Co γ radiation, where the beam entering the body through the couch will give a reduction of about 10% in skin dose. For the bone-tissue problem, experimental results imply a 3% dose reduction to tissue when irradiation is in the bone-tissue direction, and a 10% increase in the opposite direction. (UK)

7032 ELECTRON DOSE AND DOSE DISTRIBUTION MEASUREMENTS IN THE MEGARAD REGION. Dealler, J. F. B. (Southalls Ltd., Birmingham, Eng.). pp 30-4 of Radiation Dose and Dose Distribution Measurements in the Megarad Range. Slough, Eng.; United Kingdom Panel on Gamma and Electron Irradiation (1971).

From Symposium on gamma and electron irradiation; Teddington, England (6 Jul 1970). See CONF-700659.

Discussion is centered mainly on the measurement and control of radiation doses delivered by a scanned electron beam to material being irradiated for industrial purposes. Experimental work was done using a 4 MV Van de Graaff accelerator delivering a 1 mA electron beam scanned across a thin Ti window. Among matters discussed are calibration of the Perspex Red 400 dosemeters used for routine standardization against ferrous sulphate and Perspex HX and by calorimetry; dose distributions measurements using PVC sheets; and penetration of the beam in uniform and non-uniform materials. It is concluded that a wide range of materials can be satisfactorily and economically irradiated using electron beams, and that the process is particularly suited to the irradiation of materials with a low mean density such as empty containers intended for sterile filling, although good results can also be obtained with high density materials where dose rate dependent radiation damage effects make it preferable or where high radiation utilization efficiency can be obtained. (UK)

Radiation Protection

7033 (RT/PROT-(70)41) COORDINATION OF RADIOACTIVE AIRBORNE WASTE OF DIFFERENT INSTALLATIONS OF A NUCLEAR CENTER. Cagnetti, P.; Frittelli, L.; Nardi, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 4 Jan 1971. 37p. (In Italian). (CONF-700505-29). Dep. NTIS (U. S. Sales Only).

From second congress of the International Radiation Protection Association; Brighton, England (3 May 1970).

The release of airborne radioactive wastes from a modern nuclear research installation implies the solution of numerous problems, connected principally with the different functions of the existing installations (reactors, installations for the fabrication of reprocessing of fuel elements, etc.) and connected with demographic, ecological, and meteorological data of the environment around the installation. A formula is given for the release of airborne wastes adopted by the CEN on the basis of recommendations made by ICRP and on the basis of data derived from in-depth surveys of the sites and the particular characteristics of each installation. The formula permits the coordination of the circumstances of the release of airborne radioactive wastes from the different installations under normal conditions and in the case of exceptional programmed operations. (tr-auth)

7034 CRITERIA FOR ESTIMATION OF RADIATION PROTECTION SITUATION IN THE CONTACT THERAPY AND ITS APPLICATION. GDR OVERVIEW. Makedanz, A. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Z. Gesam. Hyg. Ihre Grenzbeg.; 16: 751-60(Oct 1970). (In German).

For characterizing and analyzing the radiation protection process during contact therapy with enclosed and open radiation sources, as well as for evaluating radiation protection measures and for control of their effectiveness, an index figure, or radiation exposure quotient, is proposed. The peculiarities of ^{198}Au and ^{131}I therapy were studied by means of evaluating factors. Protection against radiation from ^{60}Co, ^{137}Cs, ^{32}P, and ^{90}Sr is also discussed. The radiation exposure quotient was used for evaluation of the radiation protection effectiveness in 31 clinics. It was found that radiation exposures differed by a factor of 7 and that the radiation exposure quotient was not always lowest where the radioprotective equipment was best. Broad applications of well known index figures are discussed. (H.L.W.)

7035 RADIATION DOSE TO THE SKIN AND GONADS ON VOLUNTEER SUBJECTS UNDERGOING INVESTIGATIVE ROENTGENOGRAMMETRY, WITH A DESCRIPTION OF A NEW GONAD PROTECTOR. Jones, P. R. M. (University of Tech., Loughborough, Eng.). Hum. Biol.; 43: No. 1, 7-15(Feb 1971).

Measurements made under conditions of soft-tissue radiography of the arm, calf, and thigh for investigative purposes revealed skin doses of 12 to 23 mrad and gonad doses of <0.01 to 0.13 mrad using a new gonad protector. Inherent faults in the male and female "Armadillo" gonad protector are demonstrated and a new alternative design is reported. Emphasis must be placed on adequate filtration (not less than 3 mm al.), the use of fast films and intensifying screens, and light beam delineator diaphragms to keep the area radiographed to the minimum. (auth)

7036 PROTECTIVE SHIELD FOR RESTRICTION OF IRRADIATION LOAD ON BLADDER AND RECTUM IN INTRAVAGINAL RADIUM INSERTIONS. Michalica, W.; Picha, E. (Univ., Vienna). Geburtsh. Frauenheilk.; 29: 1115-19(Dec 1969). (In German).

The early and late side-effects of irradiation on the bladder and on the rectum are briefly described. There are discrepancies in the reported tolerated levels of radiation for both organs. A protective shield is described, made of an alloy of tungsten, copper, and nickel. It reduces the dose of radiation delivered to bladder and rectum during intra-vaginal radium insertions. The dose of radiation to the bladder is reduced by 29.9 ± 6.35 R/h, that to the rectum by 26.9 ± 3.47 R/h. The protective shield lowers the dosage to bladder and rectum by about one third of their tolerance levels during the average two intra-vaginal applications performed in our unit. Or, at the same incidence of complications, the therapeutic dose can be increased by one third. (auth)

7037 NUCLEAR SAFETY. Moulinier, J. Prot. Civ. Secur. Ind.; No. 197, 15-22(Apr 1971). (In French).

International regulations for nuclear safety exist. They concern the prevention of nuclear accidents and the measures to be taken in the event of an incident. The French legislation concerning the protection against ionizing radiations, protection in nuclear research or power plants, protection during transport of radioactive materials, and environmental protection, is reviewed. (France)

7038 CURRENT STATUS OF PROTECTION FROM IONIZING RADIATIONS IN RADIODIAGNOSIS. Lura, A.; Scutellari, P. N.; Palmieri, G. C.; (and others) (Univ., Ferrara, Italy). Bull. Sci. Med.; 141: No. 3, 225-65(Jul-Sep 1969). (In Italian).

A bibliographic review is presented of the current status of protection from ionizing radiations in radiodiagnosis. Radioprotection is considered from the viewpoint of radiobiology, establishment of radioprotection services, and legislation. 92 references. (J.S.R.)

Safety Procedures

7039 RADIATION HAZARDS IN INDUSTRY. Booth, A. H. Occup. Health Bull.; 25: No. 9-10, 4p.(1970).

Brief accounts of accidents with industrial radiation sources are given. In the first case, illustrating poor supervision of industrial radiation sources, four members of a family died of radiation sickness when a worker with a construction company took a ^{60}Co source home with him. Several workers (employed by different firms) lost fingers as the result of picking up sources with their bare hands, although aware of the hazards. Leakage due to a faulty weld on the container of a truck-mounted source resulted in contamination in three different towns. In another case, a radioactive gauge used for level indication and control in a steel furnace was sent to the plant's machine shop for modification. The source fell out when the gauge was dismantled and eight workers and the manager handled it while trying to identify the object. (Occup. Safety and Health Abstr.)

Legal Aspects

7040 VIGILANCE OF THE PUBLIC ADMINISTRATION OF THE DEPARTMENTS OF RADIOLOGY AND NUCLEAR MEDICINE OF THE HOSPITALS OF THE MILAN PROVINCE. Molese, V.; Tecce, N. (Univ., Milan). Minerva Med.; 61: 4457-61(6 Oct 1970). (In Italian).

The Province of Milan has a total of 28 hospitals containing 10,322 beds, and each hospital is equipped with x-ray diagnostic services and radiotherapy facilities that are subject to inspection by the rules of the Italian Association of Physical Sanitation. Inspections are required twice a year. The methods of inspection, including phantoms of tissue-equivalent simulation, film badges, etc., are described. An analysis is presented of the numbers of radiographic examinations and therapy treatments by the three classes of hospitals in Milan Province in the years 1962 and 1968. (K.S.W.)

Medicine

Refer also to abstracts 6872, 6877, and 6880.

Protective Substances

Refer also to abstracts 6973, 6978, and 7071.

7041 NEW DATA IN THE FIELD OF CHEMICAL RADIOPROTECTION. THE USE AND EFFECTIVENESS OF COMBINED RADIATION PROTECTIVE AGENTS. Arghittu, C. Minerva Med.; 61: No. 75, 3975-80(19 Sep 1970). (In Italian).

The more promising experimental studies on the use of combined radiation protective agents are reviewed. The protective agents discussed include AET, serotonin, cysteamine, PAPP, and glutathione. (J.S.R.)

7042 PROMOTION OF THE RESTITUTION AFTER RADIATION INJURY, AND INCREASE OF THE RAY RESISTANCE BY MEANS OF CHEMICAL COMPOUNDS AND IONIZATION RADIATION. Schwanitz, F. Magy. Radiol.; 23: No. 4, 194-200 (Aug 1971). (In Hungarian).

The author used chemical substances by means of which the consequences of radiation injury may be prevented. These substances may be given orally, they are long-acting, and in the case of plants, their effect is transmitted to later generations. According to the author's observations, small doses of ionizing radiation produce transitional stimulation of growth. The stimulation produced by the radiation may be observed in the offsprings of the irradiated plants, in some cases even as far as X_4. In the opinion of the author, the observed phenomena are due to mutations occurring in the carriers of the extra-chromosomal genetic informations in the organelles. (auth)

7043 GRAFT-VS-HOST INHIBITION. IV. PRODUCTION OF ALLOGENEIC RADIATION CHIMERAS USING INCUBATED SPLEEN AND LIVER CELL MIXTURES. **Bortin, Mortimer M.; Rimm, Alfred A.; Saltzstein, Edward C. (Mount Sinai Medical Center, New York. Medical Coll. of Wisconsin, Milwaukee). J. Immunol.; 107: No. 4, 1063-70(Oct 1971).**

An in vitro treatment of immunocompetent cells was tested in an effort to prevent graft-vs-host (GVH) disease and to promote survival of allogenic radiation chimeras. Spleen cells from adult strain-A mice were mixed and incubated for 1 hr at 37°C with liver cells from 5-day-old strain-A mice. There was no apparent decrease in hematopoietic stem cell function in the incubated liver and spleen cell mixtures when compared with stem cell function in separate cell suspensions maintained at 4°C. Severe GVH disease occurred when fresh strain-A spleen cells were given to lethally irradiated CBA mice. No mice survived longer than 33 days. Incubation of spleen cells alone for 1 hr at 37°C or incubation of liver-spleen cell mixtures for 1 hr at 4°C did not appreciably improve survival. Incubation of spleen cells alone for 2 hr at 37°C caused improved 30-day survival of the allogeneic radiation chimeras. Significant inhibition of GVH disease was also observed when lethally irradiated CBA mice were treated with strain-A spleen cells that had been incubated with strain-A liver cells for 1 hr at 37°C. (auth)

7044 SENSITIZATION OF THE RADIATION DAMAGE ON RAT EMBRYOS BY DIMETHYL-CHLOROTETRACYCLINE (LEDERMYCIN). **Fritz-Niggli, Hedi; Michel, Ch. (Univ., Zurich). Atomkernenergie; 18: No. 2, 105-8(1971). (In German).**

Experiments have revealed dimethyl-chloro-tetracycline (Ledermycin) as a powerful sensitizer of embryonic damage produced by low radiation doses. An application of Ledermycin (160 mg/kg) 1 h before irradiation of 9 days old rat embryos with 50 R increases the amount of eyes anomalies in 13-days foetuses from 27.5% (irradiation only) to 71.4%. Application of Ledermycin alone leads to a teratogenic effect (12.5%). Reparation of damage has not been observed; on the contrary, the rate of anomalies in neonatal rats becomes even higher. (auth)

7045 TERMINAL DICARBOXIMIDO ANALOGS OF S-2-(ω-AMINOALKYLAMINO)ETHYL DIHYDROGEN PHOSPHOROTHIOATES AND RELATED COMPOUNDS AS POTENTIAL ANTIRADIATION AGENTS. 2. SUCCINIMIDES, GLUTARIMIDES, AND cis-1,2-CYCLOHEXANEDICARBOXIMIDES. **Piper, James R.; Stringfellow, Carl R. Jr.; Johnston, Thomas P. (Southern Research Inst., Birmingham, Ala.). J. Med. Chem.; 14: 350-4 (Apr 1971).**

Terminal dicarboximido analogs of highly radioprotective S-2-(ω-aminoalkylamino)ethyl dihydrogen phosphorothioates and related compounds were prepared from succinimide, glutarimide, glutethimide, and cis-1,2-cyclohexanedicarboximide via 3-substituted 2-oxazolidinones. A novel method was developed for the preparation of thiosulfates in this series in which N-substituted 2-bromoethylamine intermediates were treated with MgS_2O_3 in MeOH, but such treatment of N-[2-(2-bromoethylamino)ethyl]glutarimide · HBr resulted in an unexpected condensation and formation of the bicyclic betaine thiosulfate. A departure from the general reaction scheme was also encountered in the formation of N,N′-(iminodiethylene)bis(cis-1,3-cyclohexanedicarboximide) in the preparation of 3-[2-(cis-1,2-cyclohexanedicarboximido)ethyl]-2-oxazolidinone. Of the series of thiosulfates and phosphorothioates prepared, only S-2-(2-succinimidoethylamino)ethyl sodium hydrogen phosphorothioatetrihydrate and S-2-[2-(cis-1,2-cyclohexanedicarboximido)ethylamino]ethyl sodium hydrogen phosphorothioatetetrahydrate showed good radioprotective activity in mice. (auth)

7046 RADIOPROTECTIVE ACTION OF PRODUCTS PRODUCED IN THE CONDENSATION OF GLYOXYLIC ACID AND ITS ESTERS WITH CERTAIN AMINO-THIOLS. **Jezequel, E. J. (Direction des Recherches et Moyens d'Essais, Paris); Frossard, Henri; Fatome, Marc; Perles, Rene; Poutrain, Pierre. Compt. Rend., Ser. D; 272: No. 22, 2826-7(2 Jun 1971). (In French).**

Preliminary studies of the radioprotective action of various products produced in the condensation of glyoxylic acid and its esters with cysteamine and L-cysteine demonstrated the remarkable efficiency of some of them, in particular methyl (chloro-amino-2 ethylthio)-glycolate. (France)

7047 IS THERE ANY EXPERIMENTAL EVIDENCE FOR THE APPLICATION OF RADIOPROTECTIVE SUBSTANCES IN IRRADIATION THERAPY? **Huber, R.; Teichmann, B. (Akademie der Wissenschaften, Berlin). Arch. Geschwulstforsch.; 37: No. 3, 213-45(1971). (In German).**

Influenced by the results obtained with radioprotective compounds of the group Cysteine-MEA-AET the opinion arose, that irradiation therapy of malignant tumors should be a hopeful field for the application of radioprotective substances. The experimental basis leading to this opinion was critically examined. A review was given on the most effective radioprotective compounds known at present and their partition patterns obtained with labelled substances in normal and tumor tissues and their effect on irradiation of tumors in vitro and in vivo. The results in general are discussed in relation to the opinion mentioned above. Some considerations on the experimental conditions of a series of reports induced supplementary investigations. By means of the diffusion-chamber technique it could be demonstrated that the radioprotective effect of AET and MEA on the cellular-based resistance of rats directed against Walker-Carcinoma (as a model of transplantation tumors) may be a factor which can, unrecognized, influence the results. Mice were whole-body irradiated (LD 30 to 100) using various fractionation schedules and Methylcholanthrene-Sarcoma bearing rats were locally irradiated in some fractions (LD 50). It was shown that the protective effect of MEA is connected with distinct suppositions in relation to doses of substances and irradiation. The disregard of these suppositions can lead to imperfect results and erroneous opinions. The experimental proof of a hopeful application of radioprotective agents in irradiation therapy should however not be interpreted so that this idea would be wrong on principle. (auth)

7048 DNA DAMAGE AND REPAIR FOLLOWING IRRADIATION: THE EFFECT OF 5-BROMODEOXYURIDINE IN CULTURED CHINESE HAMSTER CELLS. **Shipley, W. U.; Elkind, M. M. (National Cancer Inst., Bethesda, Md. Brookhaven National Lab., Upton, N. Y.). Radiat. Res.; 48: No. 1, 86-94 (Oct 1971).**

Cell cultures, in exponential growth, were pretreated with noncytotoxic concentrations of the thymidine analogue 5-bromodeoxyuridine (1.0 to 3.0×10^{-7} M) for about 12 generations. Two forms of DNA damage and repair following radiation were evaluated by analysis of the sedimentation patterns of the DNA released during lysis on preformed alkaline sucrose density gradients. DNA released from cells grown in the presence of 5-bromodeoxyuridine was more susceptible to degradation by alkali (no irradiation). In irradiated cells, the production and repair of single-strand breaks in DNA were not significantly affected by 5-bromodeoxyuridine pretreatment. The low-dose radiation effect on DNA—i.e., the acceleration of the release in alkali of denatured DNA from a complex of associated cellular material by doses less than about 700 rad—also may not have been affected by the incorporation of 5-bromodeoxyuridine. However, the repair of this low-dose radiation effect on the DNA complex was reduced in cells grown in the presence of 5-bromodeoxyuridine. (auth)

7049 EFFECT OF QUINACRINE ON X-RAY SENSITIVITY AND THE REPAIR OF DAMAGED DNA IN ESCHERICHIA COLI K-12. **Fuks, Zvi; Smith, Kendric C. (Stanford Univ., Calif.). Radiat. Res.; 48: No. 1, 63-73(Oct 1971).**

Quinacrine (0.15 mM), when added to the postirradiation incubation medium of E. coli K-12 rec^+ cells, markedly potentiated the killing induced by x irradiation. Alkaline sucrose gradient studies showed that quinacrine was a potent inhibitor of the repair of DNA single-chain breaks in rec^+ cells and that this inhibition was largely irreversible. The recA13 mutant (deficient in the slow repair of x-ray induced single-chain breaks in DNA) did not show radiation sensitization by quinacrine. The possible use of quinacrine as a radiation potentiator in humans is discussed. (auth)

Radiation Sickness and Injuries

7050 THERAPEUTIC EFFECT OF HETEROLOGOUS DNA ON THE COURSE OF ACUTE RADIATION SICKNESS IN MICE. **Evseeva, Nadezda K.; Uspenskaya, M. S. Radiobiol.-Radiother.; 12: No. 3, 335-45(1971). (In German).**

The effect of heterologous DNA was studied on the survival of mice who were irradiated by ^{60}Co gamma rays with a dose rate of 640 to 540 R/min with a dose of 750 R ($LD_{85/30}$) and by X rays with a dose rate of 22 R/min with a dose of 500 R($LD_{87/30}$). Preparations of DNA that were obtained from calf-thymus and from liver and spleen of rats were injected intraperitoneally in 0.5 ml solvent in doses of 0.1, 0.2, and 0.3 mg per mouse immediately, 1, or 24 hrs after irradiation. The therapeutic influence was determined by the change of weight of the mice, by the composition of the peripheral blood, by the absolute count of nucleated cells in the femur and in the spleen, by the amount of endogenous colonies in the spleen, and by the 30-days survival rate. It was found that highly polymeric DNA being obtained from calf-thymus, from liver, and spleen of rats shows the best therapeutical effect 1 hr after irradiation. The positive influence of DNA appeared in the increase of the survival rate of mice to 33 to 40% compared with 15% in the controls, in the more rapid restitution of the body weight (13th to 15th day), in a partial maintenance of the stem-cells of bone-marrow, and in a lower decrease of erythrocyte and thrombocyte content in the peripheral blood. As an optimum effective dose for DNA of calf-thymus a dose of 0.1 mg per mouse was determined and for DNA of the liver of rats of 0.2 to 0.3 mg. A difference between the effect of the preparations of DNA being kept in dry condition or in solution was not found. Effectivity of the single preparations, however, decreased in dependence on the duration of storage. (auth)

Radiodiagnosis

Refer also to abstracts 6697, 6831, 6838, 6857, 6859, 6875, 6878, 6879, 6881–6886, 6962, 6975, 7024, 7029, 7035, 7038, 7040, 7110, 7111, and 7709.

7051 SCINTIGRAPHIC EVALUATION OF MALIGNANT TUMOURS WITH ^{67}Ga CITRATE. Riccabona, G.; Scholz, K.; Bauer, H. (Chirurgische Univ., Innsbruck). Nucl.-Med.; 10: No. 3, 235-40(30 Sep 1971). (In German).

Following recent reports on the usefulness of ^{67}Ga citrate in the detection of malignancies, more than 70 patients with various malignant tumors were scanned after administration of this isotope. In addition, a comparable group of patients with benign diseases were likewise studied to evaluate the diagnostic usefulness of the method. It was found that malignancies which had been treated by intensive radiotherapy do not concentrate ^{67}Ga. If these cases were excluded, more than 90% of the malignant tumors showed a significant ^{67}Ga uptake, whereas only a single benign lesion (an abscess following mastitis) was observed to concentrate the isotope. These highly promising results are discussed for their significance in tumor diagnosis. (auth)

7052 VALUE OF ^{67}Ga SCANNING IN THE EVALUATION OF LIVER INVOLVEMENT IN HODGKIN'S DISEASE: COMPARISON WITH ^{99m}Tc-SULFUR COLLOID. Larson, Steven M.; Schall, Gerald L.; Johnston, S. (National Institutes of Health, Bethesda, Md.). Nucl.-Med.; 10: No. 3, 241-4(30 Sep 1971).

A patient with documented Hodgkin's disease was evaluated by a whole-body scan performed with ^{67}Ga citrate and a liver scan performed with ^{99m}Tc sulfur colloid. The gallium study showed two areas of abnormal, positive concentration within the liver, whereas the liver scan showed only one negative defect. ^{67}Ga scanning may be a more sensitive indicator of hepatic involvement in Hodgkin's disease than the colloid scan, and appears useful in confirming a diagnosis of malignancy in the presence of a negative defect on the liver scan. (auth)

7053 ^{85}Sr PROFILE COUNTING AND SCANNING IN EARLY DIAGNOSIS OF BONE METASTASES. Taskinen, Penti J.; Vaehaetalo, Soini (Univ., Oulu, Finland. Central Hospital of Etelae-Saimaa, Lappeenranta, Finland). Nucl.-Med.; 10: No. 3, 265-75(30 Sep 1971).

Most of the 105 patients examined in 1966 to 1968 were suspected of having bone metastases caused by a malignant tumor. They were studied by ^{85}S scanning and profile counting. The results obtained by the two methods were similar and complementary. A new method is presented for the drawing of a normal curve in profile counting in which the sources of error are reduced to a minimum through comparison with both the value for the heels and the values of vertebrae Th VII and LIV. (auth)

7054 DIFFERENTIAL DIAGNOSIS OF INTRACRANIAL PROCESSES WITH THE SCINTILLATION CAMERA. Sauer, J. (Ruhr Univ., Essen). Radiol. Diagn.; 12: No. 3, 447-52(1971). (In German).

A preliminary report is given on 1100 patients in whom brain scintigraphy was performed. They received 10 μCi ^{99m}Tc each, and pictures were taken with the scintillation camera at the following time intervals after injection: immediately, 2 to 4 minutes, 1 hour, and 3 to 6 hours. The immediate picture clearly showed stenoses and occlusions of large brain vessels as well as tumors and fresh hemorrhages. The several-minute picture showed tumors, inflammatory processes, cysts, and fresh hemorrhages. At one hour, tumors and fresh hemorrhages were still detectable. Results indicated that the method may allow differential diagnosis between various types of brain tumors. (H.B.G.)

7055 DETERMINATION OF HEPATIC CIRCULATION WITH RADIOXENON. Buchali, K.; Zimmermann, H. B.; Strangfeld, D.; Schimmelpfennig, W.; Schneider, G. (Humboldt Univ., Berlin). Radiol. Diagn.; 12: No. 3, 441-4(1971). (In German).

In 29 patients the hepatic circulation was determined with ^{133}Xe. In 6 cases the injection was done into the great portal vein, in the remaining into the hepatic artery. The portal circulation was twice as high compared with the arterial one. In cirrhosis of the liver the portal component decreases, an increase of the arterial capillary circulation is lacking. The injection into the coeliac artery yields the same values as that into the hepatic artery. The measurement of circulation after direct intrahepatic injection cannot yet be definitively judged. (auth)

7056 PHANTOM MEASUREMENTS FOR THE DETERMINATION OF THE PROBABILITY OF DETECTION OF DEFECTS OF THE VERTEBRAL COLUMN (METASTASES) BY MEANS OF THE ^{85}Sr LOCALIZATION TEST. Klein, J. (Medizinische Akademie, Magdeburg, Ger.). Radiol. Diagn.; 12: No. 3, 425-40(1971). (In German).

A paraffin-phantom with a bipartite cylindrical insertable leunite body (density = 1.75 g/cm^3) was constructed which represented as correctly as possible the anatomical as well as the radiophysical absorption and scattering properties of the vertebral column and of the overlying tissues. By insertion of different cylindrical test bodies of known ^{85}Sr-activities into the activity-homogenous part of the vertebral volumn (6.6 μCi/g) and by spectrometrical measurement of the pulse rates over the phantom in given distances, the areas of accumulation could be registered for differently used collimators. It was shown that for the localization test in isolated points of the vertebral column, a conic collimator with a focal distance of 36 mm and a conic angle of 13° (collimator length = 72 mm, average aperture 17 mm and 50 mm) has the most favorable properties of detection. A certainty of detection of nearly 100% which exceeds that of the best scanners was achieved by this collimator with an advantage factor of accumulation of 6 compared with the underground (6.6 μCi/g) and a focal extension of 1 cm with favorable conditions of measurement (duration of measurement 1 min, applied activity 100 μCi, distance of measurement about 5 cm). The dependence of the statistically evaluated probabilities of detection on duration of measurement, type of collimator, size of the test-body, and factor of accumulation is tabulated. (auth)

7057 USE OF RADIOACTIVE TRACERS IN AUTOMATING HEMODYNAMIC MEASUREMENTS. Josserand, P.; Farre, J.; Aragon, B. (Univ., Toulouse). Automatisme; 16: No. 8-9, 464-72(Aug-Sep 1971). (In French).

The basic theory of hemodynamic measurements using ^{133}Xe as the tracer is briefly reviewed: methods of electronically processing the depletion curves obtained are discussed. The method adopted is examined, and the first prototype semiautomatic flow meter developed is described. A more sophisticated fully automatic prototype is then described; this model operates in real time and provides a means of measuring the circulation index and storing the results on printed tape. (France)

7058 DIAGNOSIS WITH RADIOACTIVE ISOTOPES. II. SCINTISCANNING. Asahara, Akira (Central Hospital of JNR, Tokyo). Kotsu Igaku; 24: No. 2, 195-210(Mar 1970). (In Japanese).

Problematical points in area scanning, clinically the most important in radioisotope scanning methods, are given for scanning of the thyroid, liver, and lungs. In thyroid scanning, ^{125}I and ^{99m}TcO$_4^-$ are used besides ^{131}I, and the defect in scintigram is an important point in differential diagnosis of various disease. In liver scintiscanning, ^{198}Au colloid and ^{131}I-Rose Bengal are the representative isotopes being used. Consideration must be given to radiation energy and detector sensitivity in increasing the resolving power of a defective pattern on the scintigram in order to detect a space-occupying lesion in the liver. As an application of scintiscanning to the brain, approximately 90% rate of accuracy may be expected in the diagnosis of brain tumor and there seems to be little effect of the kind of nuclides used. According to the location of the tumor, special methods of scanning become necessary, such as tomographic scanning and the use of a scinticamera. In the case of the lung, perfusion scanning is employed using blood flow and inhalation scanning using respiration. The diagnostic value of the scintigram will increase by the combined use of x-ray photography. Commercial production of macroaggregated albumin labeled not only with ^{131}I but also with ^{125}I, ^{51}Cr, ^{99m}Tc, or ^{113m}In has become established. With administration of 200 μCi of this labeled compound, whole-body exposure dose is said to be less than 0.1 rad, and the compounds have been proved to be free from toxicity and antigenicity. (Japan)

7059 USE OF ^{99m}Tc FOR ASSESSMENT OF THYROID FUNCTION. Chebotareva, E. D.; Livergant, Yu. E.; Tsarikovskaya, N. G.; Suslina, N. G.; Nagulin, Yu. A. (Kharkov Inst. of Medical Radiology). Vrach. Delo; No. 5, 99-101(1971). (In Russian).

Technetium-99m accumulation in the thyroid of patients was determined as a function of the severity of thyrotoxicosis and changes in the thyroid resulting from ^{131}I therapy and surgery. The percent accumulation of ^{99m}Tc and ^{131}I was determined at 1, 2, 4, and 24 hr following administration of 1 to 2 mCi of ^{99m}Tc and 4 μCi of ^{131}I. Thyroid scans were obtained 3 hr after administration of ^{99m}Tc. In some patients, scans were obtained following administration of 25 μCi of ^{131}I. Isotope distribution areas in thyroid tissue were determined planimetrically. Absorption of ^{99m}Tc exceeded that of ^{131}I at 1 to 2 hr after administration, but at 24 hr, the percentage of ^{131}I was greater. The area of a ^{99m}Tc scanogram increased with increasing severity of thyrotoxicosis. The area of ^{99m}Tc distribution was greater than that of ^{131}I. Technetium-99m absorption reflected accurately the inorganic phase of iodine metabolism. The area of distribution was relatively unchanged 3 to 6 months after ^{131}I therapy, while ^{99m}Tc showed normalization. The extent of surgery following strumectomy may be revealed using ^{99m}Tc. Of eleven patients with diagnosed hypothyroidism, five showed no clear distribution of ^{99m}Tc in the thyroid, four showed a small region of increased activity, and two showed normal distribution. (E.R.B.)

7060 POSSIBILITIES AND BORDERLINES OF CORE STORE SCINTIGRAPHY OF THE LIVER. Altenbrunn, H.-J.; Markwardt, J.; Nauber, G. (Institut fuer Krebsforschung, Berlin). Isotopenpraxis; 7: No. 7, 287-96(Jul 1971).

Statistical treatment of the scintigraphically determined nuclide distribution and a form of information presentation that is optimal for evaluation seem to be the essential factors for the improvement of liver scintigraphy. These demands are met by scintigraphy with multi-channel-analyzer. Information smoothing helps to reduce the variation to about half of the original value, i.e., about 4%. For information output it is recommended to represent the processed information in the form of isocount ranges. Count range variations by more than 5% can be recorded and localized with certainty by this method. (auth)

7061 SCINTIGRAPHY AND THERMOGRAPHY IN THE EVALUATION OF THE ACTIVITY OF FIBROUS DYSPLASIA OF BONE. Umek, H.; Czitober, H.; Meixner, M.; Strassl, R. (Medizinische Univ., Vienna). Nucl.-Med.; 10: No. 3, 276-85(30 Sep 1971). (In German).

Radiological, scintigraphic, and thermographic findings were compared in five patients with proven fibrous dysplasia of bone of various localization. The radiogram often showed unilaterally localized, characteristic bone lesions that were accompanied by asymmetry of the corresponding region of the skeleton. This finding correlates in the scintigram with a significantly increased uptake of radioactivity and in the thermogram with an increased heat emission. An arrest of bone transformation as postulated for the adult age could not be observed. While radiograms allow an evaluation of the progression of the disease only retrospectively, scintigraphy and thermography offer the non-specific possibility of determining the activity of the process. (auth)

7062 SIGNIFICANCE OF A COLD MASS IN THE THYROID. Spiessens, H.; Bruggeman, H.; De Roo, M.; Steeno, O.; Ostyn, F. (Catholic Univ., Louvain, Belgium). J. Belge Radiol.; 54: No. 4, 493-9(Jul-Aug 1971).

In a series of 118 patients with a cold or cool mass on thyroid scintigraphy, we investigated the relation of the histologic lesion to the mentioned scintigraphic data. The verification was performed either by punction of the thyroid, followed by cytological examination, or by biopsy and/or operation, followed by histologic examination. We found 21% carcinomas. This figure agrees completely with that of literature. The other lesions were not or quite not studied before: we too were unable to find valuable percentages of adenoma, thyroiditis, cystadenoma, and cyst, because of the dubious diagnostic results obtained by thyroid punction. Although other authors found carcinomas of the thyroid in warm nodules, this was not the case in our series of 22 proven malignant thyroid growths. The great majority of the latter give rise to a cold zone on scintigraphy. A normal scan is rare in the carcinoma of the thyroid gland. (auth)

7063 RADIOISOTOPIC SCANNING OF THE LIVER IN LYMPHOGRANULOMATOSIS. Zubovskii, G. A.; Fil'kova, E. M.; Ryazanskaya, G. V. (All-Union Scientific-Research of Roentgen-Radiology Inst., Moscow). Probl. Gematol. Pereliv. Krovi; 16: No. 9, 44-9(1971). (In Russian).

No pathological disturbances in the liver were noted in 8 patients suffering from the I or II stage of lymphogranulomatosis; the other 48 patients with III or IV stage displayed characteristic changes in the scannogram. Comparison of the data of scanning and of laboratory studies with the clinical course of the disease permitted to differentiate hepatic disturbances (congestion and stasis, toxico-allergic, specific affection) and to carry out appropriate treatment. Focal affections of the liver detected by scanning were confirmed by morphological studies. (auth)

7064 IN VIVO MEASURE OF REGIONAL CEREBRAL BLOOD FLOW AND BLOOD VOLUME BY MEANS OF STIMULATED X-RAY FLUORESCENCE. PART A. METHODOLOGY. Ter-Pogossian, Michel M. (Mallinckrodt Inst. of Radiology, St. Louis); Phelps, Michael E.; Lassen, Margit. pp 240-7 of Role of Semiconductor Detectors in the Future of Nuclear Medicine. /Hoffer, Paul B. (ed.). New York; Society of Nuclear Medicine, Inc. (1971).

From Symposium on the role of semiconductor detectors in the future of nuclear medicine; Chicago, Ill. (12 Feb 1971).

The instruments are briefly described, and the method for x-ray fluorescence measurement of regional cerebral blood flow and blood volume is discussed. A conventional x-ray source is used to stimulate characteristic x rays from a tracer element in the blood, and the x rays are detected by a collimated Si(Li) detector. Preliminary results are briefly described. (W.H.K.)

Radiotherapy

Refer also to abstracts 7016, 7031, 7034, 7036, 7100, 7103–7106, 7108, 7109, and 7697.

7065 SILICONE RUBBER RADIUM CARRIERS FOR THE TREATMENT OF NASOPHARYNGEAL CARCINOMAS. Matz, Joseph F.; Robinson, John E. (Zoller Dental Clinic, Chicago). Oral. Surg., Oral Med., Oral Pathol.; 32: No. 5, 716-22(Nov 1971).

A silicone rubber ^{226}Ra applicator was constructed that will provide supplemental radiation therapy to patients with recurrent nasopharyngeal carcinoma. This technique provides for direct visualization of the nasopharynx and the advantage of an afterloading technique. (auth)

7066 RECENT INVESTIGATIONS CONCERNING THE QUESTION OF THE THERAPEUTIC APPLICATIONS OF ORGANIC SUBSTANCES LABELLED WITH TRITIUM. Mitchell, Joseph S. (Cambridge Univ., Eng.). Atomkernenergie; 18: No. 2, 109-14(1971). (In German).

A report on the development of radioactive drugs for selective internal irradiation in the treatment of cancer is given. At present, the majority of the studies are concerned with ^{131}I and tritium. The possibilities of the application of other radioisotopes, e.g., ^{125}I, are noted. Tritium is very suitable for this development. The most important chemical compounds under consideration are summarized, and an account is given of the experimental and clinical investigations concerning the use of tritium-labeled derivatives of tetra-sodium 2-methyl-1,4-naphthoquinone diphosphate [Synkavit]. Further investigations are necessary for the assessment of this application of radioisotopes. (auth)

7067 EXTERNAL IRRADIATION TECHNIQUES IN THYROID NEOPLASMS. Ribot, J.; Prignot, M.; Van Dorpe, J. C.; Wambersie, A. (Univ., Louvain, Belgium). J. Belge Radiol.; 54: No. 4, 485-92(Jul-Aug 1971). (In French).

The possibilities of external radiotherapy in the treatment of thyroid carcinoma are analyzed in relation to the anatomy of the neck and the target volume. Gamma rays from cobalt allow better homogeneity for bilateral irradiation of the neck, while the choice between cobalt and electron therapy should be discussed for unilateral irradiation taking into account the characteristics of the electron beam (build-up region, type of collimator etc.). (auth)

7068 THEORETICAL STUDIES ON THE DOSE-TIME-EFFECT RELATION IN RADIOBIOLOGY. Kaufmann, Horst (Ruhr-Univ., Bochum, Ger.). J. Belge Radiol.; 54: No. 4, 523-9(Jul-Aug 1971). (In French).

To interpret the effect of the time factor, the author considers that a process of regeneration takes place simultaneously either between the irradiations (during fractionated treatment) or during irradiation in prolonged low-intensity treatment). In the present study, the author seeks to apply plausible mathematical models to these phenomena of regeneration and to compare quantitatively, with the aid of the models, the action of fractionated irradiation with that of a single irradiation. The differences between the models appear to be small and, practically speaking, it is sufficient to use a purely formal method of calculation, using an exponential law (Schwarzschild). (auth)

7069 INTRA-ARTICULAR INJECTION OF ^{90}Y RESIN COLLOID IN THE TREATMENT OF RHEUMATOID KNEE JOINT EF-

FUSIONS. Oka, Martti; Rekonen, Ahti; Ruotsi, Ahti; Seppaelae, Olavi (Central Hospital, Jyvaeskylae, Finland). Acta Rheum. Scand.; 17: No. 2, 148-60(1971).

A favorable effect was obtained in 20 out of 22 rheumatoid knee joints treated with 3 to 6 mCi of ^{90}Y. Yttrium-90 resin colloid produced a fall in synovial fluid leukocytes and enzyme activity. Appreciable uptake of ^{90}Y in the regional lymph nodes occurred in some cases. Bed rest clearly reduced the leakage of ^{90}Y. The calculated radiation dose in the synovium at a depth of 1 mm. exceeded 5,000 rad. (auth)

Radiation Effects on Animals

Refer also to abstracts 6977, 6978, 6996, 7010, 7048, and 7121.

7070 REPAIR MECHANISMS IN HUMAN LYMPHOID CELLS. Drewinko, B.; Humphrey, R. M. (M. D. Anderson Hospital and Tumor Inst., Houston, Tex.). Int. J. Radiat. Biol.; 20: No. 2, 169-71(1971).

Survival characteristics of T_1 cells were determined by colony forming techniques. A dose response curve is presented for radiation doses from 0 to 1000 rads. T_1 cells showed increased survival when a total dose of 700 rads was delivered in two separate exposures of 350 rads. Dose-dependent survival experiments were also carried out with increasing doses given at intervals of 4.5 hr from 0 to 1000 rads. (UK)

7071 OXYGEN-DEPENDENT RADIOSENSITIVITY VARIATION OF MAMMALIAN CELLS. Littbrand, Bo. Stockholm; Karolinska Institutet (1971). 44p.

Thesis.

A discussion is presented based on five papers published earlier. The effect of oxygen on the survival and growth characteristics of cell lines irradiated with x rays is studied. Particular attention is devoted to the mechanisms underlying the variations in sensitivity to and repair of radiation damage. Experimental procedures used in the study are described. The modification of the cellular radiation reactions is discussed with regard to the effects of radiosensitizing and radioprotective substances in the presence or absence of oxygen during radiation treatment. Factors determining the size of the dose fractions in connection with radiotherapy for tumors are considered. (Sweden)

7072 MITOTIC DELAY AND THE REGULATING EVENTS OF PLANT CELL PROLIFERATION: DNA REPLICATION BY A G1/S POPULATION. Kovacs, C. J.; Van't Hof, J. (Brookhaven National Lab., Upton, N. Y.). Radiat. Res.; 48: No. 1, 95-106(Oct 1971).

Earlier studies with inhibitors suggested that impaired synthesis of requisite proteins for cycle progression was the cause of mitotic delay in irradiated G1 cells. Cells synchronized at the G1/S boundary were not delayed in initiating DNA synthesis, but they were subject to mitotic delay. The present experiments were designed to determine precisely where in the cycle the cells were delayed and whether disrupted protein synthesis was involved. Synchronized cells were exposed to puromycin or irradiated prior to or during DNA synthesis. Neither puromycin exposure nor irradiation prevented the cells at G1/S from initiating DNA synthesis. With populations irradiated at G1/S, DNA replication occurred uninterrupted, followed by a major prolongation of the G2 period. Exposure to puromycin or irradiation during the DNA synthetic stage, however, delayed the transit of S, demonstrating a separation of the events controlling initiation and completion of DNA replication. It was concluded that the radiosensitivity of cells in the DNA synthetic period was consistent with the hypothesis linking mitotic delay with impaired protein synthesis, and that DNA replication was unique in that it could be uncoupled from processes concerned with the initiation of DNA synthesis (G1) and cell division (G2). (auth)

7073 EFFECT OF EXTREME HYPOXIA ON RECOVERY AFTER RADIATION BY SYNCHRONIZED MAMMALIAN CELLS. Koch, Cameron J.; Kruuv, Jack (Univ. of Waterloo, Ont.). Radiat. Res.; 48: No. 1, 74-85(Oct 1971).

An evacuation system for the production of extreme hypoxia is described. With this system survival curves using asynchronous Chinese hamster cells for extremely hypoxic and aerobic conditions have a common extrapolation number and a dose-modifying factor of 3.0 to 3.1. When synchronized hypoxic cells are irradiated during the most resistant phase of the age-response cycle and kept hypoxic between doses, no recovery from sublethal damage is observed. (auth)

Invertebrates

Refer also to abstracts 7012, 7022, 7125, 7126, 7128, and 7131.

7074 CODLING MOTH CATCHES IN SEX AND LIGHT TRAPS AFTER EXPOSURE TO 0, 25, OR 40 KRAD OF GAMMA IRRADIATION. White, L. D.; Hutt, R. B. (Agricultural Research Service, Yakima, Wash.). J. Econ. Entomol.; 64: No. 5, 1249-50(15 Oct 1971).

Catches of released laboratory-reared Laspeyresia pomonella in live-female traps and in traps equipped with blacklight lamps were reduced when the moths were treated with doses of 25 or 40 krad γ radiation. Also, adults irradiated with 40 krad were less responsive than those irradiated with 25 krad. Fewer treated females than treated males were caught, no matter what the level of irradiation. Catches of 40-krad moths marked with 1% Eosin Y in ethyl alcohol were fewer than similarly treated moths marked with fluorescent dust. (auth)

7075 RELATIONSHIP OF LYSOSOMAL STABILITY TO RADIATION-INDUCED DELAY OF CELL DIVISION IN TETRAHYMENA PYRIFORMIS. Hodge, Frederick Allen. Corvallis, Oreg.; Oregon State Univ. (1971). 127p. University Microfilms Order No. 71-24,008.

Thesis.

Cell division in a heat synchronized Tetrahymena pyriformis (GL-I) cell can be delayed if the cell is exposed to x-irradiation (300 kVp, 20 mA, HVL = 0.9 mm Cu, 25 R/sec) prior to a critical time after the end of the synchronizing treatment (EST). The division delay response is correlated with a resorption of the developing new mouth as determined from silver stained cells fixed every ten minutes after EST. The length of time for the oral primordium to be resorbed increases as the dose increases and varies with the time of irradiation relative to the transition point. The all or none nature of the division delay response and the fact that cells irradiated after the transition point seemingly ignore the radiation damage until the second generation, together suggest that the damage produced by the irradiation may or may not trigger a cellular response that results in cell division delay and oral primordium resorption. The data are consistent with the hypothesis that irradiation produces damage that may or may not trigger off a cellular response that leads to delay of division. The sensitivity of the cell to being triggered to delay division may involve lysosomes. (Diss. Abstr.)

7076 EFFECTS OF BETA AND GAMMA RADIATION ON A POPULATION OF SPRINGTAILS, SINELLA CURVISETA (COLLEMBOLA). Styron, C. E. (Oak Ridge National Lab., Tenn.). Radiat. Res.; 48: No. 1, 53-62(Oct 1971).

Population dynamics of adults, juveniles, and eggs of the springtail, Sinella curviseta, were studied following acute doses of (^{90}Sr–^{90}Y) beta radiation or (^{60}Co) gamma radiation (1885 to 29,700 rads). Fecundity rates (eggs/adult/day) of adults were increased 48% by the lowest dose (1885 rads) of beta radiation, but fertility rates were reduced by radiation at all other doses. Survival values for adults suggest an apparent relative biological effectiveness (gamma/beta) of 0.497 for externally delivered beta radiation; for juveniles, 0.558; and for eggs, 0.931 as dose was measured by our methods. Gamma radiation was also more effective than beta in reducing fertility rates. Juveniles were more sensitive than adults to both types of radiation, and day-old eggs were the most sensitive stage studied. (auth)

Vertebrates

Refer also to abstracts 6973, 6997, 7013, 7042–7045, 7047, 7050, and 7127.

7077 INFESTATION OF SMALL MAMMALS WITH GAMASID TICKS ON PLOTS CONTAMINATED WITH ^{90}Sr. Il'enko, A. I. Zool. Zh.; No. 2, 243-6(1971). (In Russian).

The concentration of strontium-90 was studied in the skeletons of four rodent species (Apodemus sylvaticus, Apodemus agrarius, Clethrionomys rutilus, Microtus oeconomus) trapped on ground artificially contaminated with the radioisotope in relation to the degree of infestation with ticks. The degree of infestation of all four species was found to be higher than on the control plots. The older animals were much more infested on both contaminated and uncontaminated plots than the younger ones. The intensity of infestation of rodents caught on the contaminated plots and the density index of ticks on the animals increased with the concentration of the radioisotope and the dose rate. Ionizing radiation from strontium-90 incorporated into the skeleton of older mice weakened their resistance to ectoparasites. (JPRS)

7078 GROWTH RATE MEASUREMENTS IN GAMMA-IRRADIATED CATFISH. Roushdy, H. M.; Imam, A. E. (Atomic Energy Establishment, Barrage, Egypt. Inst. of Inland Waters and Fish Culture, Barrage, Egypt). Z. Naturforsch.; 26b: No. 9, 962-7(Sep 1971).

The effect of whole body gamma irradiation at the low exposure levels of 100, 200 and 400 R has been studied on the rate of growth of both juvenile and adult males and females of Clarias lazera. Irradiation causes, in general, significant retardation in rate of increase in length of growing fish. Such retardation is especially marked in adult females. Irradiation causes also diminution in the percentage increase in weight of adults especially the females. In juvenile fish, radiation exposure at the levels of 100 and 200 R accelerates the rate of increase in weight while the higher exposure level of 400 R results in a significant retardation. The exposure level of 100 R increases the ratio weight/length only in juveniles. Exposure levels of 200 and 400 R decrease such a ratio. The results obtained are explained in correlation with the general knowledge of biological radiation syndrome and discussed in view of the relevant literature. (auth)

7079 EFFECTS OF THE TIME INTERVAL IN FRACTIONATED X-RAY TREATMENT OF MOUSE SPERMATOGONIA. **Sheridan, William (Lab. of Radiation Genetics, Stockholm). Mutat. Res.; 13: No. 2, 163-9(Oct 1971).**

Male CBA strain mice were submitted to fractionated radiation treatment of spermatogonia. Effects of doses of 300 R + 300 R, 400 R + 400 R and 500 R + 500 R with time intervals of 24,48,72 and 144 h between irradiations were studied. Intervals of 24,48 or 72 h prolonged the post-irradiation sterile period compared with doses given in a single treatment or with an interval of 144 h. This was interpreted as an indication that the shorter intervals led to a greater amount of cell killing. In matings with CBA females all irradiated groups gave higher rates of intrauterine death and lower implantation rates than controls. Differences between irradiated groups within series imply that even the rate of dominant lethals may be increased by application of the dose in fractions. The results lead to the conclusion that time intervals of up to 72 h between irradiation doses may increase the amount of genetic damage compared with the same total dose given as a single treatment. (auth)

7080 CHANGES IN SEX PROPORTION: AN UNACCEPTABLE WAY TO ESTIMATE SEX-LINKED RECESSIVE LETHALS. **Luening, K. G.; Sheridan, William (Lab. of Radiation Genetics, Stockholm). Mutat. Res.; 13: No. 1, 77-83(Sep 1971).**

Production records from single-pair matings of offspring of the 9th and 14th generation of an irradiated mouse population, and the corresponding control population, were studied with regard to sex proportion among the young. In both generations the pairs from the irradiated population gave a lower sex proportion than the control. Analysis of single pairs with deviating sex proportions, as well as analysis of the total material with regard to litter size and sex proportion, did not support the hypothesis that the change in sex proportion could be ascribed to the presence of sex-linked recessive lethals in the material. It was concluded that change in the sex proportion is an unacceptable way to estimate sex-linked recessive lethals. In one population males were given 276 R of x rays and it was found that there was a lower proportion of males in the offspring than in controls. (H.L.W.)

7081 EFFECTS OF RADIATION ON THE RETINA OF THE DOG. **Lieberman, Lionel Melvin. Ann Arbor, Mich.; Univ. of Michigan (1970). 107p. University Microfilms Order No. 71-23,803.**

Thesis.

A radioiodinated chloroquine analogue, 4, 3-dimethyl-amino-propylamino-7-iodoquinoline-^{131}I, called NM-113, has been shown to concentrate in the pigmented choroid of the dog's eye irradiating the visual cell layer of the retina selectively with beta particles. The effects of beta radiation from ^{131}I on the retina of the dog were compared to the effects of 80 kVp x-irradiation on the dog's eye. NM-113 was administered to a group of dogs intravenously and radioactivity assays of the eye tissues were performed to obtain data for estimating absorbed beta radiation doses to the retina. From this information, the absorbed beta radiation doses to the retina from 134–1238 rad were estimated for 6 dogs given 0.34-3.1 mCi/lb of NM-113. Three dogs were treated with 80 kVp x-irradiation (70 R/min to the midplane of the eye) in doses of 200 R at intervals of 4-10 days to accumulated doses of 3600 R, 4200 R, and 4600 R, respectively. The estimated equivalent single doses (ESD) were 596 R, 1100 R, and 1240 R, respectively. The eyes from seven of these dogs were studied histopathologically for radiation effects. The retinal function of the three dogs treated with x-irradiation was evaluated repeatedly with the electroretinogram. Two dogs estimated to have received 1010 rad and 1238 rad, respectively, of absorbed beta radiation to the visual cell layer, were similarly studied. The electroretinographic parameters chosen for study were: 1. the halftime for recovery of a 30 μvolt threshold b-wave, in the dark, following either a short, weak bleach, or a long, strong bleach, 2. log threshold light intensity for a 30 μvolt threshold b-wave in the completely dark adapted dog, 3. a-wave and b-wave amplitudes after complete dark adaptation, and 4. b/a wave ratios in the completely dark adapted dogs. From tissue radioactivity assays, retinal tissue thickness measurements and dosimetry calculations using the model of the infinite, plane slab of finite thickness, it was estimated that the visual cell layer in the dog's eye will absorb 22.2 rad/μCi^{131}I/gm choroid. The expected concentration of NM-113 in the choroid from 1 mCi/lb administered intravenously was 19.2 μCi/gm. (Diss. Abstr.)

7082 PATHOLOGIC ALTERATIONS IN THE DEVELOPING RETINA. **Shively, James Nelson. Fort Collins, Colo.; Colorado State Univ. (1971). 238p. University Microfilms Oder No. 71-23,089.**

Thesis.

At birth development of the retina of the dog is comparable to that of the three or four month old human fetus. Thus, the postnatal dog provided a subject in which radiation effects could be studied over a period equal to about the last two-thirds of development of the human retina. It was necessary to determine the fine structure of the postnatal development and of the mature dog retina before evaluating the cellular and subcellular morphologic retinal changes in dogs exposed to low doses of ionizing radiation during retinal morphogenesis. The presence of two gradients of maturation in the retina prevented determination of precise times of developmental events; however, it was determined that the fine structure of postnatal development of the dog retina is similar to that reported for other species. The fine structure of the mature dog retina did not differ significantly from that described for other mammals. Evaluation of cellular and subcellular morphologic changes at selected times from one hour to six months after exposure of newborn dogs to 170R γ radiation provided details of the pathogenesis of the radiation induced dysplasia. Electron microscopy revealed degenerative changes one hour after irradiation. By the second day after irradiation about twenty percent of mitotic and post-mitotic differentiating first and second order neurons were necrotic. Only a few necrotic cells were present on the fourth post-irradiation day. At a time when the retina should have been mature there were areas in which rosettes, agenesis of outer segments, dysplasia of schleral retinal layers resulting in a mixture of outer and inner nuclear layer cells and the absence of an organized outer plexiform layer occurred. Other loci had normal structure. The lesions persisted, but some atrophy had occurred by 180 days after irradiation. The study of dose response revealed foci of severe retinal dysplasia after exposure of newborn dogs to 85R. Light microscopy detected lesions soon after exposure to 40R, but the response was minimal after 10R. However, examination of fine structure revealed excess necrosis of first and second order retinal neurons and associated degeneration of outer segments and neurites that could be detected ten weeks after irradiation. As expected lesions were not found after exposure of the mature retina to 300 and 450R. (Diss. Abstr.)

7083 EFFECT OF PRESENSITIZATION OF PARENTAL DONORS ON GRAFT-VERSUS-HOST DISEASE IN IRRADIATED F_1 HYBRID MICE. **Cosgrove, G. E.; Davis, M. L. (Oak Ridge National Lab., Tenn.). Proc. Soc. Exp. Biol. Med.; 138: No. 1, 210-12(Oct 1971).**

The GVH disease in 1C3F_1 hybrid mice following 500 R x-irradiation and injection of normal parent strain spleen cells is mild in terms of mortality, signs, and tissue pathology. Presensitization of the donor with spleen cells of the reciprocal parent strain, however, results in a highly lethal GVH disease. The timing of presensitization before donor use is an important factor in the severity of the resulting GVH disease. Presensitization of the donor seems to require more than 3 days, is near maximum effectiveness at 7 days, persists at this level for many months, and gradually falls off through the life of the donor. After 24 months, sensitized donors still are more effective in producing GVH disease than controls of comparable age. (auth)

7084 ORIGIN OF PULMONARY ALVEOLAR MACROPHAGES. STUDIES OF STEM CELLS USING THE ES-2 MARKER OF MICE. **Brunstetter, Mary-Ann (Univ. of California, Davis); Hardie, Jeanne A.; Schiff, Robert; Lewis, Jerry P.; Cross, Carroll E. Arch. Intern. Med.; 127: 1064-8(Jun 1971).**

Pulmonary alveolar macrophages (PAMs) constitute a major lung cellular defense mechanism. There is still considerable controversy concerning the cellular precursors of the resident PAM population. Genetically related RF/Al(+) and RF/Al(–) substrains of mice were used to investigate the possibility of PAM origin from marrow stem cells. The RF/Al(+) mice carry a nonspecific readily identifiable prealbumin esterase marker, Es-2. Reciprocal chimerism was produced by administering a lethal dose of x-irradiation to (1) RF/Al(−) mice and subsequently injecting them with RF/Al(+) bone marrow, and (2) RF/Al(+) mice and subsequently injecting them with RF/Al(−) bone marrow. Eight weeks after irradiation pulmonary macrophages were obtained by bronchial lavage. PAMs from RF/Al(−) animals transplanted with RF/Al(+) bone marrow showed the prealbumin esterase marker. Es-2, while PAMs from the RF/Al(+) animals given RF/Al(−) bone marrow had all but lost their Es-2 marker band, which confirms the marrow origin of PAMs. (auth)

7085 SPLENIC FIBRINOID NECROSIS IN MOUSE RADIATION CHIMERAS WITH SECONDARY DISEASE. Gude, William D.; Congdon, C. C.; Cosgrove, G. E. (Oak Ridge National Lab., Tenn.). J. Tenn. Acad. Sci.; 46: No. 2, 71-6(Apr 1971).

Fibrinoid necrosis was observed in three strains of mice following irradiation and transplantation of parental spleen or allogeneic bone marrow. Radiation alone or injection of hematopoietic cells without radiation did not induce the lesion. The presence of fibrin within areas of necrosis was confirmed with five commonly used histological stains. The morphological and staining characteristics of these lesions were identical with those generally described in fibrinoid necrosis. (auth)

7086 FETAL MANIFESTATIONS OF CONTINUOUS PRENATAL GAMMA IRRADIATION IN THE ALBINO MOUSE. Coats, Jim Allen Jr. College Station, Tex.; Texas A and M Univ. (1971). 71p. University Microfilms Order No. 71-24,657.
Thesis.

One hundred and forty-four recently bred female albino mice in groups of 24 each were exposed to gamma-irradiation continuously for the first 20 days of gestation at the rate of 22, 27, 30, 44, and 52 R/day respectively and then sacrificed. Gross examination revealed that the litter size was significantly smaller than that of the control; that the litter size of the groups treated with 44 and 52 R/day was significantly smaller than the litter size of the groups treated with 22-30 R/day; that the resorption of embryos after implantation increased with an increase in radiation dose; and that the treated fetuses weighed significantly less than the controls but did not differ significantly in length. Histologically the eye, kidney, and adrenals did not differ observably from the controls. The livers of the treated animals showed evidence of hemopoietic activity. The testes contained tubules with only a few germinal epithelium cells and had an apparent excess of interstitial cells. Thirty-four female albino mice were treated in the same manner as those sacrificed but allowed to undergo parturition in order that the effects of radiation during early postnatal development could be studied. The offspring of these treated females weighed less than those of the controls at birth. All groups except those receiving 44 and 52 R/day overcame this weight deficiency by the age of 6 weeks. The survival rate to age 6 weeks, however, was significantly lower in the group treated with 52 R/day. (Diss. Abstr.)

7087 ROLE OF THE THYMUS IN THE RECOVERY OF HEMOLYTIC PLAQUE FORMATION AFTER X-IRRADIATION. Takada, Yumiko; Takada, Akikazu; Ambrus, Julian L. (Roswell Park Memorial Inst., Springville, N. Y. State Univ. of New York, Buffalo). Proc. Soc. Exp. Biol. Med.; 138: No. 1, 216-20(Oct 1971).

Relationship between hemolytic plaque formation and repopulation of spleen and thymus after x-irradiation was studied by using two substrains of CBA mice. The CBA/H and CBA/St mice generated almost equal numbers of hemolytic plaques in the spleen at 7 days after intraperitoneal injection of sheep red blood cells (SRBC). The CBA/St mice that received 400 R of whole-body irradiation, or 600 R of irradiation and injection of 5×10^6 marrow cells, generated smaller numbers of plaques at days 22 and 29 than did CBA/H mice that received the same treatment. Bone marrows, thymuses, and spleens of sham-thymectomized and thymectomized CBA/H and CBA/St mice were almost exclusively repopulated with donor-type cells by day 22. Donor-type cells in the spleens of CBA/H mice had been "instructed" in the thymus, were seeded to the spleen, and responded to antigens, but the spleens of CBA/St mice which were also repopulated with donor marrow cells, had very small numbers of these instructed cells that were capable of responding to antigens. (auth)

7088 DIFFERENTIATION OF HYPOTHALAMIC NEUROSECRETORY CELLS IN CONDITIONS OF TOTAL GAMMA-IRRADIATION. Dedov, V. I. (Inst. of Medical Radiology, Obninsk, USSR). Byull. Eksp. Biol. Med.; 72: No. 8, 102-5 (Aug 1971). (In Russian).

Data are presented on the differentiation of secreting neurons of supraoptic and paraventricular nuclei during ontogenesis in 5-, 10- and 15-day-old rats irradiated with a dose of 200 R 10 to 12 hours after birth. Gamma-irradiation leads to a significant reduction of the size of nuclei of the supraoptical nucleus on the fifth day after irradiation, reaching a maximal decrease on the 15th day. The cytoplasm of such neurocytes contains single granules of secretions. A statistically significant reduction of the size of neurocytes is noted only on the 15th day after irradiation. A study of the ultrafine organization of axons of neurosecretory cells and their terminals in the posterior lobe of the neurohypophysis demonstrated that irradiation causes a significant increase of the quantity of "empty" vesicles; this is evidence of discharge of neurohypophyseal hormones into the blood induced by ionizing irradiation. (auth)

7089 PROGNOSTIC SIGNIFICANCE OF CONCENTRATIONS OF FOUR CLASSES OF PROTEIN-BOUND CARBOHYDRATES IN THE SERUM OF DOGS. Evans, Adelbert S.; Quinn, Frances A.; Hartley, Kenneth M. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Radiat. Res.; 48: No. 1, 32-9(Oct 1971).

Three groups of eight dogs each were given doses of 225, 230, and 400 rads of mixed gamma−neutron radiation, respectively. The doses were delivered at a rate of approximately 20 rads/min from the AFRRI-TRIGA reactor. In animals with poor prognosis, the serum protein concentrations (mg CHO/100 mg biuret protein) of neutral hexoses, hexosamines, and sialic acid started to rise at varying times in the terminal stages, continued upward, and remained high until the death of the animal. Moderate to marked fluctuations in the protein concentrations were seen in the time course of all these carbohydrates, especially in the two lower dose groups. The protein concentration of the neutral hexoses gave the clearest warning of unfavorable prognosis in the animals that died and exhibited the greatest stability in those that survived. No significant changes in the concentration of protein-bound fucose were seen in any of the 24 dogs. Serum protein-bound neutral hexose concentrations offer promise for development of a relatively simple, objective prognostic test to supplement clinical observation in cases of radiation injury. Thus, numerical ranges of protein concentrations of neutral hexoses are proposed to indicate good, guarded, and poor prognoses for this species. These tentative ranges were tested in nine additional dogs and found to be effective for prediction. (auth)

7090 ACUTE D_2O INTOXICATION OF THE RAT. Huebner, G.; Ludewig, R. (Zentralinstitut fuer Isotopen- und Strahlenforschung, Berlin. Karl-Marx-Univ., Leipzig). Isotopenpraxis; 7: No. 7, 303-4(Jul 1971).

Transperitoneal dialysis proves to be a relatively simple method of achieving a high D concentration in body water within a short time for the purpose of studying acute toxicity. In spite of the different form of progress, acute action of heavy water is approximately as toxic as chronic action. Timely re-exchange by means of transperitoneal dialysis enabled animals to be saved even after the lethal limit of concentration was exceeded. Disturbances of the cardiac stimulating function that can be partly influenced by atropine are considered the main cause of death under acute action of heavy water. (auth)

7091 SURVIVAL TIME RESPONSE OF THE MONGOLIAN GERBIL AFTER TOTAL-BODY IRRADIATION. Nelson, John M. (Univ. of Michigan, Ann Arbor). Radiat. Res.; 48: No. 1, 189-98(Oct 1971).

The overall survival-time response of the Mongolian gerbil (Meriones unguiculatus) to lethal and supralethal doses of x radiation was determined and found to be similar to that of other members of the family Cricetidae and somewhat different from that of other rodents. The central nervous system (CNS) syndrome is similar since the survival time falls from over 100 hrs at 15,000 or 20,000 rads to less than 4 hrs at 80,000 rads. Similarly, the bone marrow deaths occur within 2 weeks following doses between 840 and 1200 rads. This high minimum lethal value is a characteristic common to certain members of the family Cricetidae, and is exceptional and unique among these radioresistant species. On the other hand, certain inconsistencies were also noted. Animals dying from about 1200 rads to 15,000 or 20,000 rads live for 7 to 10 days after irradiation. This is approximately twice the normal range and it is suggested that it reflects the rate of development of the gastrointestinal (GI) lesion. In addition, a pattern of weight changes was found to correspond directly with the dose required to initiate the syndrome involved. The causal relationships are discussed and further investigation of gastrointestinal injury in this rodent was indicated. (auth)

7092 FURTHER STUDIES ON THE RADIORESISTANCE OF ANTIBODY PRODUCING CELLS: CHARACTERIZATION OF THE SURVIVAL CURVE. Sado, Toshihiko; Kurotsu, Toshitsugu; Kamisaku, Hitoko (National Inst. of Radiological Sciences, Chiba, Japan). Radiat. Res.; 48: No. 1, 179-88(Oct 1971).

An experiment was carried out to characterize the survival curve of 19S and 7S antibody producing cells exposed to suprahigh doses of radiation. The antibody producing cells were derived from spleen cell cultures undergoing secondary anti-sheep RBC response in cell-impermeable Millipore diffusion chambers and their number assessed by Jerne's hemolytic plaque procedure on agar gels and its modification. The results indicated that the number of 19S direct plaque forming cells (PFC) decreased exponentially with increasing doses, giving a survival curve with a D_0 of 6,200 R and an n_0 of 1.0. On the other hand, the survival curve for 7S indirect PFC gave a shoulder portion at doses below 15,000 R that was followed by an exponential decrease with increasing doses. This survival curve gave a D_q dose of 8,000 R, a D_0 of 4,250 R and an n_0 of 1.62. It was shown that as high as 90% or more of the hemolytic plaques observed after irradiation were indeed the result of antibodies secreted from the intact cells and not from the cellular breakdown products. (auth)

7093 OCCULT BLOOD APPEARANCE IN FECES AND TISSUE HEMORRHAGES IN MICE AFTER WHOLE-BODY X IRRADIATION. Nakamura, W.; Kankura, T.; Eto, H. (National Inst. of Radiological Sciences, Chiba, Japan). Radiat. Res.; 48: No. 1, 169-78(Oct 1971).

Appearance of occult blood in feces and macroscopic hemorrhages in various organs were examined in mice after single or multiple exposures to whole-body x irradiation. Mice irradiated at doses that produce gastrointestinal death, 1200 and 1500 R, showed no occult blood in feces and no macroscopic hemorrhages in various organs examined. We found, however, a positive occult blood reaction in feces of mice irradiated at doses that produce bone marrow death, 750 and 900 R. In these animals, we also detected gross hemorrhages in various organs, particularly in the gastrointestinal tract, pancreas, and lymph nodes. Even in mice irradiated at a sublethal dose of 600 R, we observed positive occult blood reactions in the feces. It appeared in feces during the period corresponding to the nadir of thrombocytopenia with a scope roughly proportional to the given dose. The occult blood reaction in mice irradiated at a sublethal dose of 650 R was no longer positive 2 weeks postexposure. However, this recovery was incomplete because the mice having recovered from the first exposure effect showed progressively enhanced occult bleeding responses to the second and the third exposure administered at 1-month intervals. (auth)

7094 EFFECT OF CONTINUOUS GAMMA IRRADIATION OF CHICK EMBRYOS UPON HATCHABILITY AND GROWTH. Mraz, Frank R. (Univ. of Tennessee, Oak Ridge). Contract AT-40-1-Gen-242. Radiat. Res.; 48: No. 1, 164-8(Oct 1971).

One hundred and twenty fertile White Leghorn eggs were continuously exposed to gamma rays (^{60}Co) during incubation at each of the following rates: 3.4, 1.8, 1.0, 0.9, 0.5, and 0.3 R/hr for 20 days. They were then hatched with the control eggs and hatchability and growth rate determined. Hatchability was reduced at 0.9 R/hr or higher. The irradiated embryos appeared to be weaker as evidenced by an increased number of pipped eggs that did not hatch and longer hatching times. No differences in body weight between irradiated and control chicks were apparent at hatching. The control birds were heavier at 2, 4, and 16 weeks of age than the chickens that received 1.8 R/hr or more as embryos. At these same ages, those receiving 3.4 R/hr as embryos were lighter in weight than any of the other groups. Subsequent ^{60}Co irradiation studies of 4-week-old cockerels that received 3.4 R/hr as embryos revealed an increase in mortality that suggested a residual nonrepaired damage existed from the embryonic irradiation. (auth)

7095 ANDROGEN SYNTHESIS AND METABOLISM BY RAT TESTICULAR MINCED AND TEASED-TUBULAR PREPARATIONS AFTER 450 R OF WHOLE-BODY X IRRADIATION. Ellis, Legrande C.; Van Kampen, Kent R. (Utah State Univ., Logan. Univ. of Utah, Salt Lake City). Contract AT(11-1)-1602. Radiat. Res.; 48: No. 1, 146-63(Oct 1971).

Male rats (Holtzman strain) were irradiated when 12 weeks of age and killed at 3-day intervals. Minced preparations of testicular tissue from irradiated and control rats were incubated with pregnenolone-7α-^{3}H and progesterone-4-^{14}C for androgen-synthesis studies. Minced preparations were also incubated with testosterone-4-^{14}C to measure rates of inactivation of this androgen. Teased-tubular preparations from both groups of animals were incubated with pregnenolone-7α-^{3}H and progesterone-4-^{14}C. Short-term cyclic variations were seen in androgen synthesis by both the minced and the teased-tubular preparations for control as well as irradiated animals. An increase in androgen synthesis on day 1 corresponded with previously reported decreases in melatonin synthesis by pineal glands. Testosterone synthesis from irradiated rats was diminished after day 1 by both the minced and teased-tubular preparations. Cyclic changes in testosterone synthesis with time were observed for both the control and irradiated animals for minced and teased-tubular preparations, but the irradiated animals failed to respond quantitatively to the cyclic increase in androgen synthesis when compared with the control animals. Pregnenolone was observed to be a better precursor for androgen synthesis by teased-tubular preparations than progesterone. Testosterone inactivation was increased by irradiation, but less androstenedione was formed from testosterone after irradiation suggesting that other high-polar metabolites were formed after irradiation. (auth)

7096 ELECTRICAL CONDUCTIVITY AND CHOLINERGIC ACTIVITY OF THE RAT GASTRIC MUCOSA, AT 4 AND 170 HOURS AFTER 600 R X IRRADIATION. Vaughan, Burton E.; Pessotti, Rita L. (Battelle Memorial Inst., Richland, Wash.). Radiat. Res.; 48: No. 1, 116-27(Oct 1971).

Gastric mucosas were prepared for incubation from excised whole stomachs of irradiated and nonirradiated rats. Measurements were made of transmucosal potential, direct current conductivity, and acetylcholine (ACh) response. When suitably prepared, the mucosa showed low conductivity values of 12 mmho/cm^2. Conductivity increased markedly after imposing brief electric shock (8 mA/cm^2) or after metabolic inhibition (nitrogen). The response, in both cases, was like a depolarization, with the potential decreasing concomitantly. After irradiation, a different type of response occurred after 4 hrs and after 170 hrs. After 4 hrs, the potential was elevated 40% above that of the nonirradiated control, with negligible change in conductivity. No significant change was detected in reactivity toward 10^{-3} M ACh (added to the baths). After 170 hrs, the potential was identical to that of the nonirradiated control, but conductivity showed a consistent increase of about 17%. In these cases, 10^{-3} ACh caused a more rapid inhibition of potential. ACh had no effect on conductivity in either radiation group. Analysis of the 4-hr data indicated that the acute effect of radiation was to inhibit cholinergic effector activity without affecting ACh receptor sites. In the 170-hr group, cholinergic effector activity had returned to normal, but irradiation had left the mucosa both more permeable to ions (i.e., increased conductivity) and with increased sensitivity of the ACh receptor sites. (auth)

7097 EFFECTS OF RADIATION ON THE THROMBOCYTOPOIETIC SYSTEM OF MICE. Odell, T. T. Jr.; Jackson, C. W.; Friday, T. J. (Oak Ridge National Lab., Tenn.). Radiat. Res.; 48: No. 1, 107-15(Oct 1971).

Three-month-old male RFM/Un$_f$ mice were exposed to 650 R of x rays, approximately an $LD_{50(30)}$. Their hemopoietic tissue and peripheral blood were studied at intervals, with particular reference to the megakaryocyte-platelet system. It was proposed that early increase observed in the number of megakaryocytes in femoral marrow and the early decline in platelet count result from a temporary inhibition of platelet production by mature megakaryocytes. After 2 to 3 days, the megakaryocytes and platelets began to decline, reaching a nadir at about 6 and 8 days, respectively. In relation to recent information about the timing of megakaryocytopoiesis, the time characteristics of the decline of the megakaryocyte population after radiation indicate that megakaryocytes are rather insensitive to radiation, beginning with committed diploid precursor cells. These cells continue to undergo maturation and to produce blood platelets. The dividing precursors, on the other hand, are radiosensitive. Recovery of magakaryocytes and platelets was not yet complete by 39 days, when the investigation was terminated. (auth)

7098 EFFECTS OF TRITIATED WATER AND OTHER SOURCES OF IONIZING RADIATION ON MORTALITY, GROWTH, MALE CHARACTERS, COURTING BEHAVIOR, AND THERMAL DEATH OF POECILIA RETICULATA, THE GUPPY. Erickson, Robert Carl. Seattle, Wash.; Univ. of Washington (1971). 174p. University Microfilms Order No. 71-24,034.

Thesis.

The primary objective of this study was to evaluate the effects of exposing the guppy, a live-bearing cyprinodont, to an environment of tritiated water (HTO). Effects of exposure to cobalt-60 and x irradiation were also examined. Groups of fish were irradiated either as embryos (in utero) or as young, one week after birth. Embryos were exposed for 16 to 20 days to HTO concentrations of .025 to .50 mCi/ml (90 to 2,500 rads). Young were exposed for 21 to 30 days to HTO concentrations of .05 to 1.0 mCi/ml (350 to 4,700 rads), to ^{60}Co irradiation for 21 to 30 days (8,300 to 16,000 R), and to acute x ray doses of 550 to 4,000 R. Criteria of effect were postnatal mortality, growth, sex ratio, time of appearance of male sex characters, male courting intensity, and time to thermal death. The significant changes were as follows: Postnatal mortality: No change in 60-day mortality rates was found in groups exposed to any dose of HTO up to 4,700 rads, to 8,300 R from ^{60}C, or to 1,100 R from x rays. Higher doses produced mortalities. An LD 50/30 of 2,350 R was found for young fish exposed to acute x irradiation. Growth: Both depression and stimulation of growth were found. The weight of males exposed in utero to an HTO concentration of .10 mCi/ml (350 rads) was less than that of the controls, whereas the weight of males exposed to .50 mCi/ml (2,500 rads) was almost twice the weight of controls by age 16 weeks. Sex ratio: An increased proportion of males at age 80 days was found in fish exposed in utero to .025 mCi/ml, as well as in all fish exposed in utero, combined as a whole. In the latter, the male proportion was 48% higher than for controls. Time of appearance of sex characters: Male secondary sex characters appeared earlier in fish exposed to .025 mCi/ml of HTO in utero (350 rads) and later in fish exposed to .50 mCi/ml as young (3,500 rads). Male courting intensity: Courting was depressed in fish exposed in utero to HTO concentrations as low as .20 mCi/ml (700 rads) and .50 mCi/ml (3,500 rads) when exposed as young. Thermal death: Time to death in heat-stressed fish was both increased and decreased after irradiation treatment. The survival time of fish exposed to an HTO concentration of .10 mCi/ml (350 rads) in utero increased, whereas that of fish exposed to 1.0 mCi/ml (4,700 rads) decreased. In addition to the measurement of irradiation effects, a system was developed to quantify the movement of small fish. The system makes use of the Doppler principle to measure the disturbance of ultrasound waves. A description of the equipment and data on the effects of irradiation, heat, and an anesthetic on locomotor activity are given. It was concluded that definite biological changes could be shown from exposing embryonic fish to HTO concentrations as low as .025 mCi/ml (total dose of 90 rads) and that further studies at lower concentrations using several criteria of effect are warranted. (Diss. Abstr. Int., B)

7099 EFFECT OF A LETHAL GAMMA RAY DOSE ON THE URINARY ELIMINATION OF 5-HIAA IN THE RAT. **Riotte, M.; Nouaille-Degorce, J.; Maigrot, J. C. (Univ., Lyon). Compt. Rend. Soc. Biol.; 164: No. 11, 2307-9(1970). (In French).**

The effect of a whole-body irradiation of 800 rads on serotonin metabolism was studied by the intermediate of evaluating the daily elimination of 5-hydroxy-indole acetic acid in the urine of the white rat from the first day of irradiation until the death of the rat. The same experiment was performed with a smaller dose (500 rads) during a period of 30 days. In this way, it was possible to verify that rats submitted to a dose of 800 rads exhibit an elevated 5-hydroxy-indole acetic acid excretion after the first day of irradiation, which returns to the normal value after the eighth day, and subsequently increases to a very high value; a dose of 500 rads does not modify this excretion. (France)

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Refer also to abstract 7016.

7100 HAEMORRHAGIC GASTRITIS AS CONSEQUENCE OF RADIOTHERAPY. **Koudahl, G.; Nissen, H. (Univ. of Copenhagen). Dan. Med. Bull.; 18: No. 4, 76-8(Aug 1971).**

A case of haemorrhagic gastritis induced by radiotherapy is reported, and the literature is reviewed. It is concluded that gastrointestinal radiation injuries ought to be treated surgically, because severe radiation damages are irreversible and may be misinterpreted as being cancer or recurrence of cancer. A histo logical diagnosis is decisive. (auth)

7101 CORROSION OF THE CONJUNCTIVA COMPLICATED BY CONTAMINATION BY THE ISOTOPE ^{35}S. **Rosenberg, N. (University Hospital,Blegdamsjev, Denmark). Acta Ophthalmol.; 49: 480 1(1971).**

The eye of an isotope technician was injured by the contents of a crushed ampoule. The ampoule contained the organic sulfur compound p-toluene-sulfonic acid anhydride, containing the isotope ^{35}S. The patient was immediately treated by irrigation of the eye. Examination half an hour later disclosed merely a superficial conjunctival corrosion which was excised. Activity measurements were instituted a few hours after the accident and showed appreciable contamination of the laboratory and of the technician's clothes. Less pronounced contamination was ascertained in the treatment room of the eye clinic. The content of the crushed ampoule was 5 millicurie ^{35}S, of which at most 2.5 millicurie could have hit the patient. In the periocular area an activity of the magnitude 2 microcurie was measured a few hours after the accident. Approximately two microcuries were excreted in the urine during the subsequent days. The contamination was estimated to have been reduced by a factor of 1000 by the primary treatment (irrigation). Autoradiography of the tissue removed from the conjunctiva showed the activity to be localized to the epithelial surface. The activity in the patient's urine decreased in a few days to immeasurable values, while in the periocular area activity was demonstrated for weeks. (auth)

7102 IMPORTANCE OF THE HEMATOLOGIC EXAMINATIONS IN THE ASSESSMENT OF THE RADIOLOGISTS' CHRONIC RAY LOADS (WITH SMALL DOSES). IV. **Mozsa, Szabolics Magy. Radiol.; 23: No. 4, 225-35(Aug 1971). (In Hungarian).**

The possibilities of early detection of hematologic radiation injuries are discussed. Hypersegmentation, the bilobate lymphocytes, the Heinz bodies, the Howell–Jolly bodies, the change occurring in the acid hemolysis of the erythrocytes, macrocytosis, the diminution of the Zn content of the granulocytes, the alteration of the alkaline phosphatase activity, as well as the appearance of the Philadelphian chromosome, its detection and its diagnostic value are discussed in detail. Also the possibilities of the differential diagnosis, the characteristics of the ray-hematologic examinations, and the problems of therapy are briefly outlined. Finally, some important problems arising in connection with the clinical features of the hematologic radiation disease are discussed. (auth)

7103 LINAC RADIATION EFFECT ON HUMAN GLIOMA AND GLIAL CELLS. **Kanno, Tetsuo; Kudo, Tatsuyuki; Nakazawa, Tsuneyuki; Yamada, Masahiro (Keio Univ., Tokyo). No To Shinkei; 23: No. 5, 497-505(May 1971). (In Japanese).**

Radiation effects on cultured glioma and glia cells were observed. Glioma cells (KS-1 cell line) that have retained their malignant properties after prolonged cultivation, and glia cells derived from normal human fetuses (15 weeks) were used in the study. The mean lethal dose for the KS-1 cells was 700 to 800 R. Differences in the radiation effects on KS-1 cells were observed at doses of 200 to 600 R and above 700 to 1000 R. Therefore, 700 R was considered to be the critical point for these cells. A single exposure at 700 R reduced cell growth, DNA content and metabolism, and lactate dehydrogenase activity in the KS-1 cells to 50% of the values in control (unirradiated) cells by the 7th day post-irradiation. The glucose effect, on the other hand, doubled over that of controls during the same time period. The mean lethal dose for normal human fetal glia cells was 1000 to 1200 R. A single exposure at 700 R reduced the growth of glia cells to 50% of that of controls, however, no other differences from what was observed at 500 R were noted. Therefore, 700 R was considered the smallest dose that could be administered in a single exposure that would be effective on KS-1 cells while at the same time resulting in the least damage to normal human fetal glia cells. The effects of two exposures at 700 R and seven exposures at 200 R on the growth of KS-1 cells were compared. The former fractionation schedule was somewhat more effective than the latter. This suggests that the clinical radiation doses and the method of fractionation should be reconsidered. (auth) (TSS)

7104 MANTLE TREATMENT OF HODGKIN'S DISEASE. PRELIMINARY REPORT OF SIDE EFFECTS AND EARLY RESULTS. **Landberg, Torsten; Svahn-Tapper, Gudrun; Wintzell, Knut (University Hospital, Lund, Sweden). Acta Radiol., Ther., Phys., Biol.; 10: No. 2, 174-86(Apr 1971).**

A preliminary account of side effects and early results in twelve patients with Hodgkin's disease given radiotherapy with a mantle technique is presented. Radiation pneumonitis developed in most patients. Other side effects were of less importance. No further manifestations were observed in nine out of ten patients with clinically local disease followed up for, on the average, 12 months. (auth)

7105 BLOOD COAGULATION AFTER RADIOTHERAPY OF MALIGNANT GYNECOLOGICAL TUMORS. **Nagy, I.; Krommer, K.; Gati, I.; Keller, G. (Univ., Pecs, Hungary). Z. Geburtsh. Gynaekol.; 172: 241-54(Jun 1970). (In German).**

Changes in the blood clotting system were investigated following radiotherapy of patients with carcinoma of the cervix and of the corpus uteri. Measurements were made on the following: prothrombin level, fibrinogen level, euglobulin-lysis, and thrombelastogram. Graphs are presented to show results before, during, and after treatment with external x radiation, intracavitary and radium-226 and cobalt-60 γ. It was found that a shift in blood clotting towards thrombosis occurs during radiotherapy of malignant tumors. Because of the increased risk of thrombo-embolism, prophylactic treatment with anticoagulants is indicated, particularly in carcinoma of the cervix uteri. (H.L.W.)

7106 RESISTANCE OF OCULAR NERVES TO THE ACTION OF RADIUM PLACE IN NASOSINUSAL CAVITIES. **Portmann, Georges. Rev. Laryngol., Otol., Rhinol.; 92: No. 1-2, 1-11(Jan-Feb 1971). (In French).**

In the light of observations on two cases, the possible ocular complications of intra-cavitary radium placed in the nasal cavities for malignant tumors are reviewed. In one, the patient developed oculomotor palsies, and in the other an optic neuritis. Contrary to the usual view that the question of the resistance of nerves does not have to be considered when planning irradiation, it is felt that great care should be taken with the nerves of the eye, especially with the optic nerve itself. In these two cases, the complications regressed after a few months; this was fortunate, since one of the patients had become completely blind. When dealing with malignant tumors of the ethmoid and sphenoidal sinuses, the specialist must take great care in positioning the source of irradiation as well as in planning the total dose. (auth)

7107 EFFECT OF CHRONIC IRRADIATION ON THE RESULTS OF THROMBOELASTOGRAPHIC EXAMINATIONS. Kriklava, J.; Koskova, D. (Health Inst. of Uranium Industry, Pribram, Czech.). Cas. Lek. Cesk.; 109: No. 33, 761-3(31 Jul 1970). (In Czech).

Thromboelastographic (TEG) examinations were carried out in uranium miners occupationally exposed to small radiation doses. Thromboelastographic records were compared with records of a control group. The data were statistically processed. No significant difference in basic TEG values (r, k, ma, mE, and t-ma) was found between the exposed group and the controls. Significant difference was observed in the strength of the thrombus at 90, 120, and 150 min following the onset of coagulation, and was the greater the longer a person was exposed. At this time, however, the fibrinolytic activity of the serum already became more pronounced and more effective. (NSA of Czech)

7108 INTESTINAL FISTULA AFTER PELVIC IRRADIATION AND RADICAL SURGERY. (Memorial Hospital for Cancer and Allied Diseases, New York). Postgrad. Med.; 50: No. 1, 168-71 (Jul 1971).

A case is reported of the development of an intestinal fistula following pelvic irradiation and radical pelvic surgery. The patient, a 34-yr-old woman, was originally hospitalized with a stage I epidermal carcinoma in situ of the uterine cervix with glandular involvement. Radiotherapy included radium application (2900 milligram-hrs) and ^{60}Co teletherapy (5000 rads) directed at the pelvis. A necrotic vesicovaginal fistula developed at 5 months post-irradiation necessitating radical pelvic surgery. Eight months later, an enteroperineal fistula developed. Management procedures for the fistula and the complications that subsequently developed are described. (E.R.B.)

7109 DERMAL CYLINDROMA FOLLOWING X-RAY EPILATION OF THE SCALP. Black, Martin M.; Jones, Edward Wilson (St. John's Hospital, London). Brit. J. Dermatol.; 85: 702(1971).

Two patients are described in whom single dermal cylindromata on the scalp developed many years after x-ray epilation by the Kiënbock–Adamson technique for tinea capitis. (auth)

7110 RISKS OF GENETIC DAMAGE IN ROENTGEN DIAGNOSTIC PRACTICE. Torretta, A.; Reis, F.; Pini, M. (Istituto di Radioterapia, Trieste, Italy). Minerva Med. Giuliana; 62: 776-8(25 Feb 1971). (In Italian).

The evidence of somatic and genetic damage from small doses of irradiation suggests that there is no threshold dose. The somatic and genetic injuries induced by irradiation are summarized to emphasize the need for reducing the dose to critical organs during x-ray diagnosis. (J.S.R.)

7111 INDICATIONS, LIMITATIONS, AND CAUTIONS IN RADIOLOGICAL EXAMINATIONS FOR ROUTINE PERIODICAL HEALTH CHECK-UPS. Benassi, E. (Univ., Turin); Torretta, A. Minerva Med.; 62: 975-82(7 Mar 1971). (In Italian).

The need for care in routine x-ray examinations is illustrated by the incidence of leukemia in radiologists, reduction of lifetime of radiologists, infant mortalities and leukemia in babies of women irradiated during pregnancy, and incidence of cancer in children. The use of routine x-ray examinations is questioned and the necessity for reduction of the absorbed dose if such examinations are done is emphasized. (J.S.R.)

Radiation Effects on Plants

Refer also to abstracts 6979, 6992, 7000—7002, 7011, 7015, 7017, 7042, and 7132.

7112 REVIEW OF THE LITERATURE ON THE EFFECT OF IONIZING RADIATION AND CHEMICAL MUTAGENS ON PLANTS. III. Mamedov, K.; Rakhimkulov, R. Yu. Izv. Akad. Nauk Turkm. SSR, Ser. Biol. Nauk; No. 2, 86-92(1971). (In Russian).

One- or two-line annotations are given for 66 articles, dissertations, and books in Russian (or translated into Russian) published between 1933 and 1967. The items are arranged in alphabetical order by author. Among the works listed are Chemical Mutagens and Plant Ploidy by R. N. Platonov and V. V. Sakharov, Mechanism of Action of Supermutagens by I. A. Rapoport, Methods of Detecting Induced Somatic Mutations in the Potato by Ye. A. Solomko, Effect of Chemical Mutagens and Gamma Rays on Mutability of Pea Varieties by K. K. Sidorova, Use of Ionizing Radiation in Plant Breeding by V. V. Khvostova and S. A. Valeva, Mutagenic Effect of Ethylenimine on Air-Dried Winter Wheat Seeds by N. S. Eyges, and Effect of Barley and Wheat Growing Conditions on Seed Resistance to Irradiation by S. I. Yanushkevich. (JPRS)

7113 RADIOUSTOICHIVOST SEMYAN RASTENII. (Radiation Sensitivity of Plant Seeds). Preobrazhenskaya, E. I. Moscow; Atomizdat (1971). 232p.

The comparative radiosensitivity of seeds of a large number of species and varieties of wild and cultivated plants is presented. Plant grouping according to the degree of sensitivity provides three categories: sensitive, somewhat resistant, and resistant. Correlations were established between these groups according to plant survival rates and other factors: seed germination, stimulating dose level, and plant morphology. General relations were noted between the degree of seed radiosensitivity and either evolutionary-phylogenetic origin (for large taxons), or ecological-geographical origin (for small taxons) of the corresponding plant forms. Radiation is understood here to be either x radiation or ^{60}Co gamma radiation, and a preponderance of the data stems from the latter. Extensive tables summarize the literature data on radiosensitivity. One 86-page table gives the LD$_{50}$, LD$_{70}$, and LD$_{100}$ for plants grouped by family. (244 references.) (K.S.W.)

7114 EFFECT OF URANYL IONS ON STEADY-STATE DISTRIBUTION OF MONOSACCHARIDES IN BAKER'S YEAST. Kotyk, A.; Michaljanicova, D.; Saiyid, N. H. (Inst. of Microbiology, Prague). Folia Microbiol. (Prague); 16: No. 5, 355-8(1971).

Uranyl ions have long been used as inhibitors of monosaccharide uptake by yeast. It is shown here that not only the rate of uptake but also the final distribution level is reduced. Monosaccharides transported by the specific carrier are most affected by 5×10^{-4} M uranyl nitrate while higher concentrations are less inhibitory. Monosaccharides transported by the universal carrier are affected by uranyl ions only to a lesser degree. Various hypotheses for the explanation of the effects are presented. (auth)

7115 PATTERN OF DOSE-SURVIVAL CURVE AT A REPEATED γ-IRRADIATION OF YEAST CELLS. Malinovskii, O. V.; Samoilenko, L. M. (Physical-Technical Inst., Leningrad). Tsitologiya; 13: No. 9, 1184-6(Sep 1971). (In Russian).

The dose-survival curves of yeast cells irradiated with single and repeated doses every 48 hrs were compared. Between exposures, cells were maintained in water at 30°C. Some part of samples, after both single and repeated exposure, was additionally maintained in water during 48 hrs till the recovery from lethal damages was over. Both the dose-survival curves in this case were the same, suggesting a complete recovery of cells from sublethal damages. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 6978, 6980, 6982—6984, 6991, 6995, and 7049.

7116 RECOVERY OF X-IRRADIATED BACTERIA. THE EFFECT OF SOME MUTAGENIC AGENTS. Mukherjee, P.; Bhattacharjee, S. B. (Saha Inst. of Nuclear Physics, Calcutta). Mutat. Res.; 13: No. 2, 115-22(Oct 1971).

Escherichia coli B bacteria were labeled during exponential growth with ^{32}P at a specific activity of I mCi/mg of nonradioactive phosphorus. At different storage periods, the cells were x-irradiated and allowed to recover by treating with bacterial extract. Only when the ^{32}P survival level was 80% could some amount of recovery be observed for post-x-ray doses of up to 3 krad, but beyond this dose level no restoration was possible; restoration was also unobservable in cases where the ^{32}P survivor level was 37% or less, irrespective of whether the post-x-ray doses were greater than or equal to 3 krad. The recovery which was normally observable with unlabeled control bacteria after x-irradiation was completely suppressed by the incorporation of acridine orange (AO) dyes into either test or donor organisms. With 5-bromodeoxyuridine-incorporated E. coli 15 TAU-bar cells (requiring thymine, arginine and uracil for their growth in synthetic media), similar suppression of repair activity could be observed. The cause of inhibition of extract-promoted recovery in x-irradiated bacterial populations under the influence of different mutagenic agents has yet to be understood. (auth)

7117 SURVIVAL AND DNA BREAKDOWN AFTER GAMMA IRRADIATION IN SYNCHRONOUSLY-GROWING ESCHERICHIA COLI B. Trgovcevic, Zeljko; Qerimi, Haqif; Miletic, Branimir

(Inst. Ruder Boskovic, Zagreb). Int. J. Radiat. Biol.; 20: No. 2, 163-8(1971).

To determine whether the extent of radiation-induced DNA degradation is influenced by the process of cell fission or by the commencement of DNA replication cycle, experiments with synchronously-growing E. coli B bacteria were performed. The results showed that the extent of DNA breakdown was the same throughout the cell-division cycle, indicating that DNA degradation was related neither to cell fission nor to the DNA replication cycle. Certain variations in survival occurred during the cycle, correlated with the DNA content per cell. This suggested that a recovery mechanism, depending on the process of genetic recombination, was responsible for fluctuations in sensitivity. (UK)

7118 EFFECT OF GAMMA RADIATION ON SERRATIA MARCESCENS. COMPARISON OF THE RADIOSENSITIVITY OF PIGMENTED AND NONPIGMENTED CELLS. Webb, Paul S.; Neff, Richard D.; O'Donovan, Gerard A. (Texas A and M Univ., College Station). Radiat. Res.; 48: No. 1, 40-52 (Oct 1971).

The effect of ^{60}Co gamma radiation on the production of the red pigment, prodigiosin, in pigmenting and nonpigmenting strains of Serratia marcescens was examined. When colony-forming ability, after gamma radiation, is measured, the nonpigmenting strains are more radioresistant than their parental pigmenting strain. However, when the pigmenting strains are grown at temperatures that preclude pigmentation (40°C), they were found to be more sensitive than those cells grown at temperatures that allow pigmentation (30°C). This suggests that prodigiosin is not an endogenous radiosensitizer but that an intermediate in the bifurcated pathway to prodigiosin may be a radiosensitizing substance. Methods to identify this possible endogenous radiosensitizer are described. (auth)

7119 RecA$^+$-DEPENDENT REPAIR OF GAMMA-RAY DAMAGE TO ESCHERICHIA COLI DOES NOT REQUIRE RECOMBINATION BETWEEN EXISTING HOMOLOGOUS CHROMOSOMES. Bridges, B. A. (Univ. of Sussex, Brighton, Eng.). J. Bacteriol.; 108: No. 2, 944-5(Nov 1971).

Chemostat-grown Escherichia coli showed recA$^+$-dependent resistance to gamma radiation even though between 50 and 75% of the population possessed only a single unreplicated genome, suggesting that recombination between homologous chromosomes before replication is not necessary for manifestation of recA$^+$-dependent resistance to gamma radiation. (auth)

7120 MECHANISMS INVOLVED IN NONGENETIC REACTIVATION OF FROG POLYHEDRAL CYTOPLASMIC DEOXYRIBOVIRUS: EVIDENCE FOR AN RNA POLYMERASE IN THE VIRION. Gravell, Maneth; Cromeans, Theresa L. (St. Jude Children's Research Hospital, Memphis. Univ. of Tennessee, Memphis). Virology; 46: No. 1, 39-49(Oct 1971).

Mechanisms involved in nongenetic reactivation of frog polyhedral cytoplasmic deoxyribovirus (PCDV) were studied by plaque assay and the technique of DNA-RNA hybridization. Results of these studies were as follows: Nongenetic reactivation of PCDV occurred predominantly via interaction with single cells of virus aggregates containing protein denatured (heat- or urea-inactivated) and ultraviolet light (uv)-inactivated virions. Little reactivation occurred by coincidence encounters with cells of separate protein denatured and uv-inactivated virions. In untreated and cycloheximide-treated baby hamster kidney and fathead minnow cells, reactivable heat-inactivated PCDV could not initiate synthesis of viral RNA, while PCDV inactivated by brief uv-exposure had limited capacity. Under the same conditions, potentiated amounts of viral RNA were made in cells mixedly infected with a combination of uv- and heat-inactivated PCDV. Additionally, the reactivating capacity of uv-inactivated PCDV was not reduced in direct relation to the uv dose it received. From these results, it was concluded that gene expression by uv-inactivated PCDV virions was not essential to obtain reactivation of heat-inactivated PCDV virions. Viral RNA was synthesized in cells blocked in their capacity for protein synthesis by cycloheximide treatment, suggesting that an RNA polymerase is an integral component of the PCDV virion. (auth)

7121 BIOLOGICAL EFFECTS OF SPACE FLIGHT ON THE LYSOGENIC BACTERIA E. COLI K-12 (λ) AND ON HUMAN CELLS IN CULTURE. Zhukov-Verezhnikov, N. N.; Volkov, M. N.; Rybakov, N. I.; (and others). Cosmic Res. (USSR) (Engl. Transl.); 9: No. 2, 267-73(Mar-Apr 1971).

Translated from Kosm. Issled.; 9: No. 2, 292-9(Mar-Apr 1971).

Various space vehicles were used to expose strains of an intestinal bacillus-carrier of episome factors (the lysogenic bacteria E. coli K-12 (λ), the colicinogenic strain E. coli CA-23 (D), and E. coli 200 PS with F-Lac$^+$ episome, and also cultures of cells of the lines Hela, A-1, fibroblasts, and Cave K-10). It is shown that, under the conditions of space flight of a certain duration, there is an induction of bacteriophage and a reduction in the proportion of cells carrying F-Lac$^+$ factors in the integrated state. Space flight did not affect the frequency of the bacteria's auxotrophic mutations and their enzymatic synthesis of β-galactosidase, induced by isopropyl-β and D-galactoside. After quadruple exposure in space, a culture of cells of the Hela line showed alterations in the cells' morphology and the character of their growth, intensification of proliferating activity, and enhancement of antigenic properties. Possible mechanisms of the biological effect of space flight are discussed. (auth)

7122 STIMULATION OF GROWTH OF LACTIC ACID BACTERIA BY γ-IRRADIATED GLUCOSE-AMINO ACID MIXTURE. Ueno, Teruo; Yoshizako, Fumiki; Nishimura, Atsuo; Nomura, Takehiro. Annu. Rep. Radiat. Center Osaka Prefect; 11: 146-50(1970).

The effects of γ-irradiated glucose and glucose-amino acid mixture on the growth response of lactic acid bacteria (Lact. acidophilus and Lact. bifidus) were investigated. Autoclaving glucose in the basal medium resulted in a marked enhancement of growth of the test organisms, whereas sterilization of glucose separately by filtration had no such effect. The irradiated glucose showed somewhat better growth of the test organisms than filtered glucose. The effect of irradiated glucose-amino acid mixtures on growth showed a different pattern among the test organisms. In L. bifidus, the effect of irradiated one was almost the same as or a little better than the unirradiated one, however, it was less than the autoclaved one. On the other hand, in L. acidophilus, addition of glycine, lysine, or threonine to the glucose solution stimulated growth remarkably, but some amino acids such as isoleucine, glutamic acid, arginine, and alanine had an inhibitory effect. The effects of irradiated glucose and glucose-amino acid mixture seemed to be a shortening of the lag phase of growth, and once growth was initiated, the rate of growth and also the final cell crop were almost independent of the presence of irradiated glucose or glucose-amino acid mixture. The amount of reducing substance formed by irradiation was not parallel with the growth stimulation of L. acidophilus. (auth)

7123 POST-IRRADIATION RECOVERY OF THE CELL. II. THE SURVIVAL OF E. COLI B AFTER EXPOSURE TO UV-, γ- AND α-RAYS DEPENDING ON THE PHENOTYPIC EXPRESSION OF THE LON$^-$ MUTATION. Zhestyanikov, V. D. (Inst. of Cytology, Leningrad). Tsitologiya; 13: No. 9, 1148-56(Sep 1971). (In Russian).

The survival (S) and the filament formation (F, the fraction of filaments in the lethal effect) in E. coli B after exposure to uv-, γ- and α-rays during the growth on complete nutrient media at 19, 37, and 44°C were studied. A close reverse dependence is observed between S and F without irradiation and under exposure to uv- and γ-rays, that causes a decreasing in the survival by 1 to 2 orders, and upon α irradiation in small doses. Under uv- and γ irradiation in doses decreasing the survival by 3 or more orders, and under exposure to α particles in large doses, no correlation between S and F is observed. The most intensive filament formation is observed after exposure to uv, the least occurs after γ irradiation, and the least filament formation is seen after α irradiation. Differences in the survival of E. coli β caused by different modes of irradiation and temperature conditions of the growth after irradiation cannot be explained only by the phenotypic expression of the lon$^-$ mutation. (auth)

Radiosterilization and Radiopreservation

Refer also to abstracts 6694, 7031, and 7122.

7124 (IAEA-R-480-F) EFFECT OF GAMMA IRRADIATION ON THE KEEPING QUALITY OF SOME FRESH FRUITS. Final Report, December 20, 1966-March 19, 1970. Terui, Mutsuo (International Atomic Energy Agency, Vienna (Austria)). 1970. 16p. INIS.

Several species of fungi and Jonathan apples were irradiated with ^{60}Co gamma rays at various doses (0 to 2000 kRad) and dose rates (20 to 1000 kRad/hr). The irradiated fungus and the fungus isolated from the irradiated apples were cultured under suitable conditions. The irradiated apples were stored in a common refrigerated room (0°C) and a controlled atmosphere room (0°C). The apples stored for 0 to 6 months were examined organoleptically and chemically. The results were tabulated in seven progress reports. The following conclusions were drawn. From the pathological point of view, the fungicidal or fungistatic effect on the occurrence of decay in stored apples was recognized so long as the dose was 500 kRad or more and was weakened by interrupted irradiation. On the other hand, it was observed that a dose of 200 kRad lowered the eating quality of apples. Since some fungistatic effect could be expected at this dose, about 200 kRad could be applied to apples used for beverage purposes. The undesirable effect was negligible at 50 kRad to about 10 kRad. Finally, a dose of about 5 kRad may be recommended for the pretreatment of common refrigerator or CA storage of Jonathan apples. (auth) (INIS)

7125 BIOLOGICAL EFFECTS OF IRRADIATION WITH THERMAL NEUTRONS ON BOLL WEEVILS FED BORIC ACID CONTAINING ^{10}B. Flint, H. M. (Agricultural Research Service, Fargo, N. Dak.); Walk, E. L.; Klassen, W.; Greenberg, D. J. Econ. Entomol.; 64: No. 5, 1002-8(15 Oct 1971).

Studies were conducted to determine whether the boron reaction (n,α) could be used to increase the sterility induced in the boll weevil, Anthonomus grandis, by irradiation with thermal neutrons. When reared on larval diet containing 0.01 or 0.1% boric acid ($H_3^{10}BO_3$) and irradiated with fluences of 1.34 to 2.25 × 10^{13} N_{th} (N_{th}/cm^2/sec × time = fluence) weevils showed no increased mortality or sterility because of the boron. When fed diet containing 0.1% boric acid and irradiated with 1.53 × 10^{12} to 1.50 × 10^{13} N_{th}, adult weevils had 10- and 2-fold greater mortality and sterility, respectively, than weevils fed regular diet and irradiated with the same fluences. Irradiation of males when fed boric acid caused greater sterility than in similarly treated females, although fecundity was reduced also in irradiated females. Males that survived 2 to 3 weeks recovered fertility. At least 0.01% boric acid was required in the adult diet to obtain increased mortality and sterility at 8.14 × 10^{12} N_{th} compared with irradiated males which were fed regular diet. Increased mortality was obtained when one to four days elapsed between feeding and irradiation, whereas increased sterility was obtained when no more than two days elapsed between feeding and irradiation. When fed 0.1% boric acid and irradiated with 2.5 krad rays adult weevils had no increased sterility or mortality from the boric acid. (auth)

7126 COMPARATIVE EFFECTIVENESS OF FAST NEUTRONS AND GAMMA RAYS IN PRODUCING STERILITY IN HOUSE FLIES. Smittle, B. J. (Agricultural Research Service, Gainesville, Fla); LaBrecque, G. C.; Carroll, E. E. J. Econ. Entomol.; 64: No. 5, 1030-2(15 Oct 1971).

When both sexes of the house fly, Musca domestica, were exposed as three day old pupae to fast neutrons or γ rays oviposition was completely inhibited by 200 rad of neutrons and by 1500 R of γ rays. Also, when both sexes were treated, 100 rad of neutrons and 1000 R of γ rays caused better than 90% sterility, though only 60 to 68% sterility occurred when only males were irradiated. Complete sterility in males was produced by 300 rad of neutrons and by 2000 R of γ rays. Thus, fast neutrons are 6.7 to 10 times as effective as γ in producing sterility in house flies. (auth)

7127 COMPETITIVENESS OF GAMMA-STERILIZED MALES OF THE MEDITERRANEAN FRUIT FLY. Hooper, G. H. S. (International Atomic Energy Agency, Seibersdorf, Austria); Katiyar, K. P. Contract AT(30-1)-2043. J. Econ. Entomol.; 64: No. 5, 1068-71(15 Oct 1971).

Male Ceratitis capitata given γ doses of 1 to 17 krad two days before adult eclosion were confined with untreated males and females in ratios of 5 : 1 : 1, 9 : 1 : 1, and 19 : 1 : 1. With the first two ratios, the egg hatch of treatments using 5-, 7-, 9-, or 11-krad-treated males was not significantly different despite an increase in male sterility from approximately 89 to more than 99%. In the 19 : 1 : 1 ratio experiment, the 7-krad treatment gave the lowest egg hatch, and it was significantly lower than that for the 11-krad treatment. Males irradiated with greater than 3 krad were less competitive than untreated males based on a comparison of observed and expected egg hatch. When the competitiveness of the irradiated males was quantified, it was clear that as the dose increased male competitiveness decreased. (auth)

7128 STERILIZATION OF THE BEET LEAFHOPPER: INDUCTION OF STERILITY AND EVALUATION OF BIOTIC EFFECTS WITH A MODEL STERILANT (OM-53139) AND ^{60}Co IRRADIATION. Ameresekere, R. V. W. E.; Georghiou, G. P. (Univ. of California, Riverside). J. Econ. Entomol.; 64: No. 5, 1074-80(15 Oct 1971).

Fourteen chemicals comprising alkylating agents, organotin compounds, an antimetabolite (aminopterin), and an antibiotic (porfiromycin) were evaluated as chemosterilants of Circulifer tenellus. Topical application and contact exposure were found unsatisfactory, but oral administration in sucrose solution through parafilm membranes was satisfactory and was employed throughout the study. Apholate and tepa were toxic at sterilizing dosages. Metepa, tepa, and Compound I (N,N′-hexamethelene bis-1-aziridinyl carboxamide) were the most effective sterilants; hempa was the least effective. Because of high sterilant activity and low toxicity, Compound I was selected as a model compound for detailed study. Male leafhoppers were somewhat more susceptible than females to the toxic as well as to sterilant action of Compound I. Susceptibility was highest in late-stage nymphs and it decreased in both sexes with advancing age. High degree of sterility was evident when matings were performed immediately after a 24-hour acquisition period, and it increased to a plateau at 48 hours, remaining constant for the entire one-month period of observation. Females which mated to sterile males remained monogamous provided the first copulation was long enough (approximately 1.6 minutes) to insure passage of seminal fluid. Chemosterilized males, when confined at various ratios with normal males and females, were found to be sexually as competitive as nonsterile individuals, both under optimum environmental conditions and under temperature stress. Sterilization of the insect by ^{60}Co γ irradiation was also demonstrated, 95% sterility being obtained with doses of 16 to 20 krad for males and 4 to 6 krad for females. (auth)

7129 EFFECT OF IONIZING RADIATION ON APPLE JUICE CONCENTRATED BY FREEZING. Kiss, Istvan; Farkas, Jozsef (Zentralforschungsinstitut fuer Lebensmittelindustrie; Budapest). Mitt. Rebe Wein Obstbau Fruechteverwert.; 20: No. 4, 296-304 (Jul 1970). (In German).

Tests were carried out to find out to what extent radiation influences the storage life of concentrates produced from Jonathan apples by the freezing method. At temperatures of 20 to 30°C, the keeping quality of apple juice containing 10% dry substance was 3 to 4 days, that of apple concentrate containing 50% dry substance 21 to 24 days. At a storage temperature of 2 to 3°C, the increase of the dry substance ratio from 10 to 50% increased the durability 16 to 17-fold. A gamma radiation dose of 13 Mrad was not sufficient to produce microbiological stabilization of a concentrate containing 30% dry matter and having a live microorganism count of 3 × 10^5/ml. But the durability of a concentrate with 46.7% dry substance and a live microorganism count of 1.5 × 10^4/ml was increased appreciably by a radiation dose of 0.5 Mrad, and a radiation dose of 1.3 Mrad has ensured a durability of at least 10 months at room temperature. As a result of the radiation, the concentrates lost a certain amount of their color, but this returned again in the course of storage. The taste and smell of the concentrates were not influenced by a radiation dose of 1.3 Mrad. After a storage period of 3 weeks, the concentrate with 46.7% dry matter exposed to a radiation of 1.3 Mrad received practically the same average number of points during organoleptic testing as it did several days after radiation. (auth)

7130 EFFECTS OF GAMMA IRRADIATION ON ENZYME ACTIVITIES OF GREEN MALT. Kim, Byung Mook; Kim, Hyung Soo. J. Korean Agr. Chem. Soc.; 11: 131-6(1969).

For the study of the effects of low gamma irradiation on malt enzymes, barley seeds were irradiated with ^{60}Co at doses of 10, 100, 1,000, and 10,000 rads. The results of experiments on the germinated green malt were as follows. At doses below 1,000 rads, the fresh weights of green malts increased, but at doses of 10,000 rads they decreased. At all doses, α-amylase activity and saccharifying ability were expedited, showing the increased effects of 26 to 69% and 87 to 178% respectively, reaching their peaks at 100 rads. Protease activity showed almost no changes at doses below 1,000 rads and decreased remarkably at doses of 10,000 rads. Reducing sugar contents of green malts were decreased, particularly at 100 and 1,000 rads. Soluble protein contents of green malts were increased at all doses and had their highest value at 100 rads. (Korean Sci. Abstr.)

7131 INSECT DISINFESTATION OF PEANUTS BY GAMMA RADIATION. Brower, John H.; Tilton, Elvin W. (Agricultural Research Service, Savannah, Ga.). J. Ga. Entomol. Soc.; 6: No. 3, 199-203(Jul 1971).

Inshell and shelled peanuts were seeded with Plodia interpunctella (Hubner), Tribolium castaneum (Herbst), or Oryzaephilus surinamensis (L.) and then treated with 10, 20 or 40 krad of gamma radiation. Progeny production by the beetles was greatly reduced or eliminated by the 10 krad treatment, and at higher levels no offspring were produced. Plodia were not controlled by the 10 krad treatment and a few survived the 20 krad treatment. Control was complete with 40 krad. A practical level of insect control in bulk peanuts could probably be achieved by a 20 to 25 krad treatment, and complete disinfestation should be achieved by a 40 krad treatment. (auth)

7132 EFFECTS OF HEAT AND ^{60}Co IRRADIATION ON THE ASCOSPORES OF BYSSOCHLAMYS FULVA IN VARIOUS FRUIT JUICES. Partsch, G.; Richter, O.; Altmann, H. (Reaktorzentrum, Seibersdorf, Austria). Mitt. Rebe Wein Obstbau Fruechteverwert.; 20: 234-40(1970). (In German).

Tests were conducted to see whether it was possible to stop the growth in fruit juices of the thermoduric ascospores of Byssochlamys fulva by means of gamma irradiation and heating applied simultaneously. In a previous test irradiation at 20°C showed that 250 krad sufficed to prevent the germination and growth of the oscospores in three different fruit juices. In these experiments it was found that heating of apple, grape and orange juice and simultaneous irradiation of 180 krad for the grape and orange and 160 krad for the apple juice suffice to guarantee a three months' storage period at 37°C. At 50°C (with pre-treated spores) the irradiation dose can be reduced by about 20 to 40 krad, but the operation is technically more difficult to perform. (auth)

7133 FLAVOR CHANGES IN GAMMA IRRADIATED FRUIT JUICES. Fetter, F.; Stehlik, G.; Kovacs, J.; Weiss, S. (Reaktorzentrum, Seibersdorf, Austria). Mitt. Rebe Wein Obstbau Fruechteverwert.; 19: 140-51(1969). (In German).

From the tests carried out it was found that gamma irradiation alone is not sufficient to preserve fruit juices, unless noticeable deterioration in taste is to be caused. The degree of deterioration, however, varies greatly with the type of drink. In general, clear juices are influenced to a much greater extent than are those containing fruit pulp (nectars). In addition, it was found that, as with various other foodstuffs, the proteins are probably to a high degree responsible for the changes in flavor. (auth)

7134 EFFECT OF IONIZING RADIATION UPON THE SPROUT INHIBITION, LOSS OF WEIGHT, AND RESPIRATION IN POTATO TUBERS. Ojima, Tsutomu; Hori, Shiro; Toratani, Hirokazu; (and others). Annu. Rep. Radiat. Center Osaka Prefect.; 11: 139-42(1970).

The sprout inhibition induced by irradiation of potato tuber, Danshaku variety, was investigated. A dose of 10 krad at the dose rate of 2×10^4 rad/hr or more was sufficient to prevent sprouting. Gamma radiation reduced weight losses of potato tubers during storage. Immediately after irradiation, a considerable increase in respiration was observed that seemed to be mostly ascribed to the increase in cortex part. (auth)

7135 RADIATION-INDUCED BROWNING OF VASCULAR REGION IN POTATO TUBERS. Ojima, Tsutomu; Hori, Shiro; Toratani, Hirokazu; (and others). Annu. Rep. Radiat. Center Osaka Prefect.; 11: 143-5(1970).

The appearance of browning in the vascular region of irradiated potato tubers was related to the increase of respiration of the tubers. The respiration of tubers increased after irradiation, reaching the maximum level at the first day after irradiation. This increase of respiration was reduced by low temperature (4°C) storage, and increased by taking out to open air temperature, and the browning in the vascular region was observed. However, in the tubers that were irradiated at 2 months after harvest, browning was not observed regardless of the storage temperature. It was proposed, for the tubers harvested in the south-western part of Japan, that irradiation for sprouting inhibition be done at the time between 2 months after harvest and the natural sprouting time. (auth)

7136 STERILIZATION OF DEXTRAN POWDER BY GAMMA IRRADIATION. Farkas, Erzsebet; Pandula, Egon (Semmelweis Orvostudomanyi Egyetem Gyogyszereszeti Intezet, Budapest). Acta Pharm Hung.; 41: 63-8(Mar 1971). (In Hungarian).

The possibility of radiosterilization of dextran was investigated. The radiolysis was well followable in dextran samples irradiated with increasing doses. Gamma irradiation yielded in the samples decomposition products having acid reaction and an intensive absorption at 265 n.m. At the same time the average molecular weight of the irradiated sample significantly decreased. The investigation of the molecular weight of the irradiated sample indicates that radiolysis can yield decomposition. The splitting of the molecules having several chain-length was carried out in equal probability. The decrease of radiolysis is advanced by the previous reduction of the moisture content of the sample, as well as by the removal of the oxygen content of the atmosphere. Not even in the light of these viewpoints had the authors success in completely eliminating radiolysis by the application of 2.5 Mrad sterilizing dose. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstract 6765.

7137 URAN I EGO SPLAVY. (Uranium and Its Alloys). Sokurskii, Yu. N.; Sterlin, Ya. M.; Fedorchenko, V. A. Moscow; Atomizdat (1971). 448p.

This monograph is a collection of production methods, and properties of uranium and its alloys. One chapter is devoted to the refining of uranium and to metalloceramic powders of that metal. The physical deformation of α-, β-, and γ-U and appropriate mechanisms are discussed, as well as the effects of mechanical and thermal treatments. Binary alloys of U are grouped and discussed according to the solubility of the second metal in U. Thus Al, Be, Bi, Fe, Si, Mg, Ni, Ta, Th, and Cr have low solubility; but V, Mo, Nb, Pu, Ti, and Zr alloys with U are treated in a following chapter. Diffusion in U alloys, the effects of radiation on U and its alloys, pressing and rolling procedures are topics individually treated. The last chapter is concerned with the manufacture of fuel elements. A substantial number of references are placed at the end of each chapter. (K.S.W.)

Corrosion and Erosion

Refer also to abstract 8556.

7138 (AEC-tr-7287) CORROSION OF ZIRCONIUM ALLOYS IN SUPERHEATED STEAM: RESULTS OF LONG-TERM TESTS. Gruetter, A. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Translated from report EIR-184. 35p. Dep. NTIS.

Seven alloys (Ozhennite, Zr–1.5 Nb, Zr–Cu–Fe, Zr–Cr, Zr–Cr–Si, Zircaloy-2, and Zr–2.5 Nb) were investigated for their corrosion characteristics in 50 atm steam at 350 and 450°C over long periods of time and up to high weight increases. With the exception of Zr–1.5 Nb, an exponent of about 3 at 350°C and one of 2.5 at 450°C was found for all alloys in the pretransition region. The alloys differed very markedly in the transition point data. Photomicrographs showed voids in all post-transition oxides. These voids were frequently arranged in layers parallel to the surface. Crack formation perpendicular to the surface occurred relatively late in the post-transition region. Zr–Cu–Fe was an exception at 450°C. With regard to hydrogen absorption, a linear relation with the oxygen absorption was generally found at 450°C in the post-transition region. Very great differences were found insofar as Zr–2.5 Nb absorbed only 20% while Zr–Cr–Si absorbed 100% of the theoretical corrosion hydrogen. In the pretransition region hydrogen absorption proved to be negligible at 450°C compared to that in the post-transition region. At 350°C the relations with respect to the hydrogen absorption were too complicated to permit conclusions. (P.C.H.)

7139 (NYO-1710-105) MICROSCOPIC STUDIES OF OXIDIZED HIGHLY ORIENTED PYROLYTIC GRAPHITE. Rodriguez-Reinoso, F.; Thrower, P. A. (Pennsylvania State Univ., University Park. Dept. of Materials Science). [1971]. Contract AT(30-1)-1710. 19p. Dep. NTIS.

Microscopic examination of a highly oriented pyrolytic graphite reacted with oxygen revealed some unusual structural features. It was found that oxygen attack occurs on basal plane surfaces to produce channels at crystallite boundaries, monolayer pits at lattice vacancies, and deeper pits at some unidentified structural defects. It is argued that these defects are not non-basal screw dislocations but may be associated with some structural irregularity which occurred during deposition. The depth of these pits (~10 μm) was much larger than the crystallite dimension, L_c (~500Å). At the edge surfaces, where the majority of the oxidation occurred, preferential attack was evident from channels which appeared to follow random paths into the material up to 120 μm long. These were suggestive of catalytic attack but no catalyst particles have ever been observed. On some edge surfaces a blocky structure was observed, which may be related to terraces in the basal plane pits. These observations indicate the presence of a structural macrounit containing several crystallites, highly oriented but separated by basal plane twist boundaries. (auth)

7140 (ORNL-4625) COMPATIBILITY OF STRONTIUM COMPOUNDS WITH SUPERALLOYS AT 900 AND 1100°C. DiStefano, J. R.; McHenry, R. E. (Oak Ridge National Lab., Tenn.). Nov 1971. Contract W-7405-eng-26. 49p. Dep. NTIS.

The compatibility of $SrTiO_3$, Sr_2TiO_4, and SrO with Haynes alloy No. 25, Hastelloy C, and type 316 stainless steel was evaluated in tests for up to 10,000 hr at 900 and 1100°C. Both $SrTiO_3$ and Sr_2TiO_4 were compatible with all three superalloys at either temperature. Some reaction resulting in a slight reduction of $SrTiO_3$ was found, but it did not have a significant effect on the superalloys. A reaction between SrO and Haynes alloy No. 25 and Hastelloy C occurred at 900°C. The reaction was more extensive at 1100°C and also included type 316 stainless steel; however, it appeared to reach steady state after 5000 hr. In commercially produced Hastelloy C or C-276, the reaction with SrO appears to be related to the presence of one or more intermetallic phases. In laboratory heats containing very low silicon but relatively high carbon or in alloys containing very high silicon, these phases do not form and no attack was observed. In addition to the reactions reported, a theoretical discussion of several types of reactions that could occur in these systems is presented. The effect of an in-growth of zirconium due to decay of ^{90}Sr is also discussed. A reduction in the room-temperature mechanical properties of Haynes alloy No. 25, Hastelloy C, and type 316 stainless steel was noted after heat treating at 900 or 1100°C. A further reduction in ductility was found in some of the samples exposed to SrO. (auth)

7141 OXIDATION BEHAVIOR OF Ni-Cr-1ThO_2 ALLOYS AT 1000 AND 1200°C. Davis, H. H. (Central Research Labs., Wright-Patterson AFB, Ohio); Graham, H. C.; Kvernes, I. A. Oxidation Metals; 3: No. 5, 431-51(Sep 1971).

The oxidation behavior of Ni–13.5 to 33.7 Cr–1 ThO_2 alloys in flowing oxygen at 150 torr was investigated in the temperature range 1000 to 1200°C. Gravimetric measurements of the oxidation kinetics have been combined with microstructural studies of the reacted samples in order to evaluate the reaction mechanisms. The oxide products formed on the alloys were a function of Cr content, sample surface preparation, reaction time, and temperature. The presence of ThO_2 appears to produce two effects during alloy oxidation. First, enhanced Cr diffusion to the alloy surface results in rapid formation of a Cr_2O_3 subscale beneath NiO on Ni–13.5 Cr–1 ThO_2 and selective oxidation of Cr for Ni–22.6 Cr–1 ThO_2. Second, the mechanism of formation of Cr_2O_3 is apparently different from that for simple Ni–Cr alloys, resulting in about an order of magnitude reduction in the Cr_2O_3 growth rate. The oxidation vaporization of Cr_2O_3 to CrO_3 becomes rate controlling for the higher Cr alloys after only a few hours of exposure at 1200°C. (auth)

7142 CATASTROPHIC OXIDATION OF ZIRCALOYS IN FUSED SLATS AT 300°C. Cox, B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Oxidation Metals; 3: No. 5, 399-430(Sep 1971).

Very rapid oxide film growth and severe intergranular penetrating oxidation of unstressed Zircaloy specimens have been observed in fused eutectic mixtures of $NaNO_3$–KNO_3–NaCl and $NaNO_3$–KNO_3–KBr at 300°C. Studies of the oxide films produced showed that the accelerated film growth rate is associated with a change in oxide crystallite morphology, which affects the ionic transport process, coupled with a large decrease in the electronic resistivity of the oxide. The onset of intergranular penetration is determined by the development of porosity in the surface layer; no gross cracking or spalling of the oxide occurs until a late stage in the deterioration of the specimen. The penetrating intergranular oxidation does not stifle itself because an open channel is maintained along the plane of the original grain boundary surface. Severe attack in air or steam can be caused by minute deposits on specimens of NO_3'–Cl′ salts which are molten at the oxidation temperature. Examples of such attack in-reactor have been identified. (auth)

7143 FLEXURE MEASUREMENTS ON A U-Nb-Zr ALLOY DURING OXIDATION AND TEMPERATURE CYCLING. Pawel, R. E.; Cathcart, J. V. (Oak Ridge National Lab., Tenn.). J. Electrochem. Soc.; 118: No. 11, 1776-81(Nov 1971).

As part of a general program to study the fundamental oxidation characteristics of a uranium-7.5 wt % niobium-2.5 wt % zirconium alloy, measurements of the flexure of thin specimens reacting on one side were utilized to assess the extent of stress generation during oxidation. During the early stages of the reaction at 700°C, rapid flexing of the specimens was observed. Because the depth or thickness of the layer involved in this reaction was small, the stress within this zone must have been large to account for the observed bending stresses. The model relating flexure to a uniform stress in the growing oxide film appeared to be applicable and led to film stress values of the order of 10^6 psi. When the oxidation process was interrupted, the high stresses then dissipated rapidly as the reaction slowed. This behavior was analyzed in terms of a balance between stress generation and relief in both the oxide film and the substrate metal. Flexure measurements were also used during thermal cycling of these specimens to study the kinetics of the structural transformations exhibited by this alloy. The presence of an elastic stress gradient was found necessary to promote significant flexure during the transformation period in these specimens, suggesting that shear forces play an important role in the transformations, particularly those involving the α'' structure. (auth)

7144 ELECTRICAL BREAKDOWN IN ANODIC OXIDE FILMS ON ZIRCALOY-2. Ramasubramanian, N.; Trottier, T. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Electrochem. Soc.; 118: No. 11, 1797-1804(Nov 1971).

In Zircaloy-2/anodic oxide, 250 to 2500 Å thick/gold structures, three types of electrical breakdown characteristics were observed. By comparing the breakdown characteristics of oxide films grown on the alloy in the as-received condition and vacuum-cooled or quenched from the β phase conditions (Widmanstätten and martensitic type structures, respectively) it was possible to identify the location of a majority of the initial breakdown spots with that of a few of the second-phase particles. (auth)

7145 REFLECTIONS ON IMPROVEMENT OF OXIDATION STABILITY OF ZIRCONIUM AND ZIRCONIUM ALLOYS. Hauffe, K. (Univ., Goettingen, Ger.). Werkst. Korros.; 22: No. 7, 604-12(Jul 1971). (In German).

The formation of defects in oxide layers on metal surfaces in general is discussed. Then, the oxidation of zirconium is discussed in detail. Above 350°C, which is the transition point, oxidation rapidly increases, the oxide layer becomes porous, and finally begins to flake off. To reduce the oxidation rate and to prevent flaking, two methods appear promising. First, the finding of a suitable additive to the alloy which enters the oxide layer. Second, the finding of a suitable additive which accumulates at the interphase alloy-oxide layer, increases ductility, and prevents diffusion of hydrogen. Various possible additives are discussed. (H.B.G.)

7146 CORROSION OF METALLIC ZIRCONIUM IN FUSED ALKALI-METAL CHLORIDES SATURATED WITH HYDROGEN CHLORIDE. Krasil'nikova, N. A.; Smirnov, M. V.; Ozeryanaya, I. N.; Shamanova, N. D. Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial; No. 15, 102-8(1970). (In Russian).

An experimental study, including measurements of steady-state potentials, was made of Zr corrosion in alkali-metal chloride melts of various compositions at 800 to 950°C. The presence of HCl increased the corrosion rate. Good agreement was obtained between the experimentally determined corrosion rates and those calculated from electrode potential values. (Referativnyi Zh.)

Preparation and Fabrication

Refer also to abstract 6578.

7147 (RMI-17) SEMIANNUAL PROGRESS SUMMARY, JANUARY-JUNE 1971. (RMI Co., Ashtabula, Ohio). Aug 1971. Contract AT(30-1)-1405. 31p. Dep. NTIS.

Uranium extrusion related process development and improvement progress is summarized for the period January-June, 1971. Projects covered are extrusion lubrication evaluation, K-factor studies, the effect of extrusion parameters on surface quality, cold extrusion, anisotropy study, tooling design optimization, and a program to improve machining yields through either the reduction of machining overstock or extrusion to final size. Owing to the continuing nature of these projects and the need to further evaluate tentative conclusions, no final conclusions are presented. (auth)

7148 NEW FORGING PROCESSES FOR BERYLLIUM. Blech; 17: No. 9, 15-17(Sep 1970). (In German).

The advantages of Be as an aerospace material are outlined and the production of components by forging, extrusion, and rolling is discussed. Data are given on the mechanical properties in axial and tangential directions for components made by various methods. Working in one direction leads to pronounced anisotropy. (Metals Abstr.)

7149 CHEMICAL METHOD OF MACHINING BERYLLIUM FOIL. Belyayeva, I. A. Russian Patent 229,163. 6 Feb 1969. Filed 9 Oct 1967. (In Russian).

To improve the technology of depositing galvanic coatings on Be foil 50 to 200 microns thick, a chemical method of machining the latter using an aqueous NH_3 solution is proposed. It is indicated that this affords preservation of the vacuum density of the foil and increases the strength of adhesion of coating with base. (JPRS)

7150 PRODUCTION OF ELECTROLYTIC Ti-Zr ALLOY POWDERS. Olesov, Yu. G.; Cherkashin, V. I.; Rubtsov, A. N. J. Appl. Chem. USSR (Engl. Transl.); 44: No. 4, 938-9(Apr 1971).

Translated from Zh. Prikl. Khim.; 44: No. 4, 933-4(Apr 1971).

The production of electrolytic Ti-Zr alloy powders of predetermined chemical composition is described. The experiments were carried out in a laboratory cell with a voltage of approximately 2.7 to 2.8 V. The electrolyte was an equimolar mixture of NaCl and KCl with additions of $TiCl_2$ (or $TiCl_3$) and $ZrCl_4$. The temperature was maintained at 800 ± 10° during electrolysis. In the presence of $TiCl_2$ the Zr content in the cathodic metal increased continuously with increasing $ZrCl_4$ concentration in the electrolyte, while in the presence of $TiCl_3$ the increase in the Zr content in the cathodic metal was limited. With an increase in the cathodic current density from 0 + 8 to 2.4 A/cm² the yield of cathodic metal of fine particle size (<280 μ) increased from 60 to 92%. Increases in the cathodic and anodic current densities increased the Zr content in the metal and powder, respectively. (P.C.H.)

7151 EFFECT OF ALLOYING ELEMENTS ON THE PROPERTIES OF Ni-Cr-Mo-V STEEL FOR LARGE ROTOR FORGINGS. Fukuda, Etsuro (Mitsubishi Steel Mfg. Co. Ltd., Nagasaki). Mitsubishi Seiko Giho; 5: No. 1, 23-8(Feb 1971).

The unit capacity of generators for thermal power plants and nuclear power plants is increasing in recent years. Consequently, these plants require rotor shafts of ever increasing dimensions; also better qualities and fabrication techniques are demanded. The effects of C, Ni, and Cr on the characteristics of Ni-Cr-Mo-V steel for rotor shaft were examined and an empirical formula that offers a comparatively close quantitative estimate of the relationship between these alloying elements and characteristics of steel was obtained. (auth) (Japan)

7152 MAGNIETERMIYA. (Magnesium Thermite). Samsonov, G. V.; Perminov, V. P. Moscow; Izdatel'stvo Metallurgiya (1971). 176p.

The use of magnesium powder for reducing compounds of other metals to the free metal, analogous to the older Thermite process, is the subject of this monograph. Data are furnished on the chemical interaction of binary and ternary systems and on the thermodynamics of these processes. Metals are grouped for discussion according to their group or subgroup of the periodic system. Of particular interest here is the treatment of the transition metals Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W, Mn, Tc, Re; in most cases the conversion of the chloride to the metal in a suitable autoclave is briefly considered. (300 references) (K.S.W.)

7153 MECHANISMS OF FORMATION OF DIFFUSION ALUMINIDE COATINGS ON NICKEL-BASE SUPERALLOYS. Goward, G. W.; Boone, D. H. (Pratt and Whitney Aircraft, East Hartford, Conn.). Oxidation Metals; 3: No. 5, 475-95(Sep 1971).

Studies on microstructures and compositions of model diffusion aluminide coatings coupled with existing information on diffusion in nickel-aluminum intermetallic compounds indicated that only two basic types of these coatings can be formed on nickel-base superalloys. The first type was formed by inward diffusion of aluminum from coating media of sufficiently high aluminum activity to cause formation of the $\delta(Ni_2Al_3)$ phase. Subsequent stabilizing heat treatments required for practical use of this type of coating caused some outward diffusion of nickel to form a three-zone β (NiAl) coating. The second type was formed by outward diffusion of nickel from the substrate alloy to react with aluminum of suitable activity to stabilize that β (NiAl) phase of composition through which only nickel motion can occur. This process produced a two-zone β (NiAl) coating. It follows that the structural type of coating to be expected from any given coating process can, in principle, be predicted from knowledge of the aluminum activity present during formation of the coating. The initial stages of diffusional degradation of these coatings involved continued outward diffusion of nickel from the substrate through the β (NiAl) coating with the resultant dilution of aluminum content of the coating; little inward diffusion of aluminum occurred. (auth)

7154 ELECTROLYTIC SEPARATION OF TUNGSTEN FROM MOLTEN CHLORIDES. Baraboshkin, A. N.; Saltykova, N. A.; Talanova, M. I.; Martem'yanova, Z. S. Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial; No. 15, 67-8(1970). (In Russian).

A layer of tungsten was electrolytically deposited at 750 to 800°C which exhibited extreme adherence to the support material. The current density at the cathode was 0.03 to 0.05 A/cm². The molten chloride salt mixture was chiefly $CsCl-Cs_2WCl_6$, containing from 4 to 10 weight percent of tungsten. (K.S.W.)

7155 ELECTROPLATING OF MOLYBDENUM IN MOLTEN SALTS. Baraboshkin, A. N.; Shunailov, A. F.; Martynov, V. A.; Martem'yanova, Z. S. Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial; No. 15, 51-9(1970). (In Russian).

Mo was plated on Ni, Fe, Cu, and graphite from a molten mixture of $CaCl_2-CaMoO_4-CaO$ at 950°C in air. The effects of Mo and Ca concentrations, temperature, current density, and support material on the structure of the resultant coating were studied. In all cases the structure was acicular with axes ⟨111⟩. (K.S.W.)

7156 ELECTROLYSIS OF CHLORIDE–MOLYBDATE MELTS. Baraboshkin, A. N.; Shunailov, A. F.; Martynov, V. A. Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial; No. 15, 44-50(1970). (In Russian).

The polarization of Mo, Ni, Cu and graphite electrodes was studied in $CaCl_2-CaMoO_4-CaO$ melts in atmospheric air and at temperatures in the neighborhood of 900°C. Electrolysis products corresponding to different portions of the polarized cathode curves were examined. At current densities 0.01 to 1 A/cm^2 at 800°C Mo_2O_3 separated out at the cathode; above 850°C a complex precipitate of metallic Mo separated. The stoichiometry of the reactions involved is discussed. (K.S.W.)

7157 HOT PRESSING OF TUNGSTEN AND ITS PSEUDO-ALLOYS. II. Karpinos, D. M.; Kravchenko, A. A.; Pilipovskii, Yu. L.; Tkachenko, V. G.; Shamatov, Yu. M. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 5, 367-72(May 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR.; 10: No. 5, 27-34(May 1971).

It was established that densification in the hot pressing of tungsten and its pseudoalloys is accomplished through several processes, each of which predominates in a particular density range. At a relative density of 0.45 to 0.6, regrouping and dense packing of particles play the main part. In the density range 0.6 to 0.8, the process is controlled chiefly by plastic deformation in the particle contact zones. At higher densities, diffusional creep becomes the dominant factor. Mathematically, the densification process in the hot pressing of tungsten and two-component tungsten-containing mixtures in which one component becomes transformed in the course of pressing into a liquid phase having no chemical affinity for the solid-phase component can be satisfactorily described on the basis of the mechanism of volume-viscous flow of a compressible liquid within the framework of the Koval'chenko–Samsonov equation at relative densities of the tungsten of 0.6 to 0.95 provided that the viscosity coefficient is proportional to the square of isothermal holding time. At an initial relative density of the tungsten of <0.6, it is necessary to introduce an additional term describing the initial stage of densification. (auth)

7158 KINETICS OF THE CHEMICAL VAPOR DEPOSITION OF TUNGSTEN FROM TUNGSTEN HEXAFLUORIDE BY HYDROGEN REDUCTION. Huggins, Hugh Wilbur. Salt Lake City; Univ. of Utah (1971). 124p. University Microfilms Order No. 71-24,497.

Thesis.

Tungsten formed by the chemical vapor deposition of tungsten hexafluoride by hydrogen reduction has the theoretical density of 19.3 grams per cubic centimeter, and tends toward anisotropic growth. The order of the reaction is temperature dependent. At low temperatures, about 550°C, the reaction is second order with respect to tungsten hexafluoride and second order with respect to hydrogen. At a temperature of 685°C, the reaction is second order with respect to tungsten hexafluoride and first order with respect to hydrogen. At very high temperatures, the entire reaction occurs in the gas phase. The energy of activation is 15.6 kcal/mole. At low temperatures, the reaction proceeds as follows: $WF_6 + H_2 = WF_4 + H_2F_2$ (Vapor Phase Reaction); $WF_6 + WF_4 = F_3WF_3WF_4$ (Vapor Phase Reaction); $F_3WF_3WF_4$ + Surface = $F_3WF_3WF_4$/Surface (Surface Reaction); 2 H_2 + Surface = 2H_2/Surface (Surface Reaction); $F_3WF_3WF_4$/Surface + 2H_2/Surface = W/Surface + WF_6 + 4HF. The adsorption of hydrogen on a tungsten surface has an exothermic reaction up to 75 kcal/mole; therefore it is doubtful if the reaction is right on the surface. At high temperatures the reaction is as follows: $WF_6 + H_2 = WF_4 + H_2F_2$ (Vapor Phase Reaction); $WF_4 + H_2 = WF_2 + 2HF$ (Vapor Phase Reaction); $WF_6 + WF_2 = F_3WF_3WF_2$ (Vapor Phase Reaction); $F_3WF_3WF_2$ + Surface = F_3WF_3-WF_2/Surface (Surface Reaction); H_2 + Surface = H_2/Surface (Surface Reaction); $F_3WF_3WF_2$/Surface + H_2/Surface = W/Surface + WF_6 + 2HF. At very high temperatures, the reaction occurs as follows: $WF_6 + H_2 = WF_4 + H_2F_2$ (Vapor Phase Reaction); $WF_4 + H_2 = WF_2 + 2HF$ (Vapor Phase Reaction); $WF_2 + H_2 = W^0 + 2HF$ (Vapor Phase Reaction). The reaction may be forced to poison the reaction surface or to "chew" tungsten from the surface. (Diss. Abstr. Int., B)

7159 REFINING OF HAFNIUM AND ZIRCONIUM IN CHLORIDE MELTS. Ivanovskii, L. E.; Chashchikhin, V. A.; Rozanov, I. G.; Batukhtin, V. P. Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial; No. 15, 18-23(1970). (In Russian).

It is possible, by means of a gaseous Cl electrode to saturate fused halide electrolytes with Hf and Zr chlorides up to the concentration necessary for their refinement. Hf has been deposited from such electrolytes. Consideration is given to the conditions required for producing compact deposits of Group IV and V transition metals from halide electrolytes. (Referativnyi Zh.)

7160 PREPARATION OF COMPACT TUNGSTEN DEPOSITS BY ELECTROLYSIS OF CHLORIDE MELTS. Baraboshkin, A. N.; Saltykova, N. A.; Talanova, M. I.; Martem'yanova, Z. S. Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial; No. 15, 67-8(1970). (In Russian).

Electrolysis of chloride melts containing 4 to 10 wt % W for the production of compact W is described. With a cathodic current density of 0.03 to 0.05 A/cm^2 at 750 to 800°C a well-adhering bright grey deposit of metallic W is obtained. The deposit is composed of needle-like crystals which become larger as the deposit layer thickens. (Referativnyi Zh.)

7161 Zr Hf NEWSLETTER, SEPTEMBER 1971. Akron, N. Y.; AMEX Specialty Metals, Inc. (1971). 18p.

A review of developments in the technology related to these methods is presented. Information is included on Hf, Hf-containing alloys, Zr, Zr-containing alloys, compounds of Hf and Zr, and production of Hf and Zr. 323 references are included. (J.R.D.)

7162 FABRICATING TECHNIQUES FOR FUELS CONTAINING PLUTONIUM. Ayer, J. E. Metalurgia (Sao Paulo); 26: No. 153, 615-20(Aug 1970). (In Portuguese).

Problems and experience related to the use of Pu in fuel elements are reviewed. The set of processes used to fabricate a 28% Pu–2.5% Mo–U alloy into elements for the ZPPR (Zero Power Plutonium Reactor) is outlined. Injection molding of fuel pins of U–Pu–Zr and U–Pu–Ti alloys for EBR-II (Experimental Breeder Reactor II) is discussed. With reference to the fabrication of fuel slugs for the FFTR (Fast Flux Test Reactor), the compaction of spherical particles of the compound UO_2-PuO_2 in cylindrical containers by means of low-energy vibration is considered. (Metals Abstr.)

7163 PHYSICOCHEMICAL STUDY OF TITANIUM FILMS DEPOSITED ON COPPER AND TARGETS OF TITANIUM. II. STUDY BY MEANS OF ELECTRON PROBE AND EXAMINATION OF TARGETS AFTER BOMBARDMENT BY DEUTERONS. Peters, J. M.; del Fiore, G. (Univ., Liege). Radiochem. Radioanal. Lett.; 8: No. 4, 205-17(5 Dec 1971). (In French).

An electron probe was used to explore films, impregnated or not with hydrogen isotopes. These films deposited on Cu were treated thermally under different conditions. Experiments confirmed directly the diffusion of Cu and Ti, and showed different Cu–Ti phases already detected by x rays. When studied with x rays and the electron probe, the impact volume of the targets previously placed in an accelerated deuteron beam, indicated a diffusion process that could be slowed down but not eliminated by cooling the targets during bombardment. The diffusion of Cu in the film, before impregnation, limits the charge of Ti by hydrogen isotope so that the ratio H/Ti = 2 cannot be reached under the experimental conditions the targets are prepared. The Cu diffusion interferes on the degassing of the targets under bombardment. (auth)

Properties Evaluations

Refer also to abstracts 6766 and 7239.

7164 (FOA-4-4471) LITERATURE SEARCH AND PRIMARY STUDY OF URANIUM ALLOYS. Liljas, Mats (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Aug 1971. 45p. (In Swedish). Dep. NTIS (U. S. Sales Only).

In a literature search on uranium alloys, metallurgical and mechanical properties were investigated. The purpose was to find a material with a high threshold of breaking stress and break elongation combined with a high density. Twenty-seven alloys were selected for a metallurgical test, which resulted in a final choice of four alloys. (36 references) (Sweden)

7165 (HEDL-TME-71-118) PREPARATION, CHARACTERIZATION, AND TESTING OF AUSTENITIC STAINLESS STEEL WELDMENTS. Ward, A. L.; Irvin, J. E.; Blackburn, L. D. (Hanford Engineering Development Lab., Richland, Wash.); Slaughter, G. M.; Goodwin, G. M.; Cole, N. C. (Oak Ridge National Lab., Tenn.). Aug 1971. Contract AT(45-1)-2170. 81p. Dep. NTIS.

Weldments were prepared from one-inch thick Type 304 stainless steel plate using the submerged-arc, gas metal-arc, gas tungsten-arc, and shielded metal-arc processes. The weldments were prepared at two different laboratories using different filler materials but nearly identical joint design. The results of the tensile tests performed at temperatures between 600 and 900°F indicated a significant difference between the properties of the weld metal and the base metal. Weld metal was much less ductile and had a higher yield strength. Creep-rupture tests at 1000 and 1100°F showed that, depending upon the specific weld-process and filler-metal combinations, the creep properties of weld deposited metal can be very similar or different from those of the parent metal. (auth)

7166 (NMAB-281) REPORT OF THE AD HOC COMMITTEE ON BERYLLIUM. (National Materials Advisory Board (NRC), Washington, D. C.). Oct 1971. 106p.

A review was made to examine the role of the Department of Defense in using beryllium and in advancing the technology. Numerous advantageous applications as part of important components were found. Improved system performance is attributable to beryllium's elastic, thermal, and nuclear properties, and its low density combined with adequate strength. The outstanding technical limitation for structural application is beryllium's low fracture toughness. It has become apparent that while few, if any, systems absolutely require beryllium, when used, performance was sufficiently improved to outweigh the expense and risks involved. Present applications, such as for guidance systems, brakes, and thrust chambers, would suffer significant performance penalties if beryllium were not available. Several design trade-offs show beryllium to be competitive with, or superior to, filamentary composites, on a stiffness-to-weight basis, in advanced applications for lightweight structures. Increased usage of beryllium, however, will be unlikely without certain necessary development work which is described. In addition to beryllium's unique capabilities, a major justification for support of beryllium technology is its usefulness as an option in the event that competitive materials prove to be unsatisfactory in critical applications. Civilian applications (except in the form of an alloying element), now or foreseeable, are very limited because beryllium remains an expensive material. Accordingly, fulfillment of beryllium's potential advantages for military systems requires government support to ensure that beryllium in the required forms will be available, particularly for applications now being designed. Evaluation of pertinent standard cutting and forming operations and also some of the newer fabrication operations in terms of cost and applicability are recommended. In addition, the construction and evaluation of prototype hardware, based on either all-beryllium or hybrid-beryllium structures, are recommended to capitalize upon available beryllium technology, and to establish the experience, data base, and confidence necessary to keep beryllium as a viable candidate for future military systems. To assure coupling of the materials suppliers, designers, and fabricators, the prototype program should be managed as part of an advanced development system. (auth)

7167 (ORNL-4739) EFFECT OF OXYGEN IN STATIC SODIUM ON VANADIUM AND VANADIUM ALLOYS. Klueh, R. L.; DeVan, J. H. (Oak Ridge National Lab., Tenn.). Nov 1971. Contract W-7405-eng-26. 36p. Dep. NTIS.

Static capsule tests were used to investigate the effects of oxygen in sodium on vanadium and vanadium alloys. When unalloyed vanadium in a vanadium capsule was exposed at 600 and 800°C to sodium that contained up to 1500 ppM O, the specimen and capsule gettered all the oxygen. Vanadium specimens were also exposed to sodium containing up to 4000 ppM O at 600°C in capsules of type 304L stainless steel and molybdenum. Except when the sodium contained over 2000 ppM O, all oxygen was gettered. It was concluded that the oxygen distribution coefficient between vanadium and sodium, that is, the ratio of the oxygen concentration in the vanadium to that in the sodium, at equilibrium, is greater than 10^4. To compare the effects of oxygen in sodium on various vanadium alloys with that on unalloyed vanadium, specimens of the alloys and unalloyed vanadium were simultaneously exposed to sodium containing 2000 ppM O. Alloys tested were: V-5% Cr, V-10% Cr, V-15% Cr, V-20% Ti, V-15% Cr-5% Ti, V-1.3% Zr, V-5% Zr, V-20% Mo, Vanstar 7, Vanstar 8, and Vanstar 9. The results on the alloys can be divided into two groups: alloys that formed internal oxides and those that did not. Of the alloys tested, only the chromium alloys and the V-20% Mo did not form internal oxides. Both chromium and molybdenum lowered the solubility of oxygen in vanadium, results that were explained in terms of the effect of chromium and molybdenum on the activity coefficient of oxygen in vanadium. The remainder of the alloys contained dissolved titanium or zirconium, which precipitated oxides when oxygen was gettered by these materials. Observations on the internally oxidized alloys are discussed in terms of existing internal oxidation theory. (auth)

7168 (RPI-3820-5) STUDY OF THE EFFECT OF HYDROSTATIC PRESSURE ON SELF-DIFFUSION RATES IN HEXAGONAL METALS. Annual Progress Report. Gilder, H. Michael (Rensselaer Polytechnic Inst., Troy, N. Y.). Oct 1971. Contract AT(30-1)-3820. 5p. Dep. NTIS.

The thermal expansion coefficient of an activated vacancy in Zn and Cd was found to be $\alpha_V = 1/T$. Plots of ΔH vs p for both metals give slopes of essentially zero. It is shown that the thermal expansion of the activated vacancy can account for the curvature in the Arrhenius plot of Na. A preliminary diffusion run in thallium at 4 kbar and 300°C is reported. The activation volume data for Zn and Cd indicate no anisotropy between the volumes associated with the basal and nonbasal vacancy jumps. (D.L.C.)

7169 (STU-68-261/U-208) STUDIES ON THE THERMODYNAMICS OF THE OXIDATION OF METALS IN HIGH-TEMPERATURE MILIEU. Lewis, Derek; Svensson, Birgit; Pourbaix, Marian de; Johansson, Karin; Johansson, Kerstin (Aktiebolaget Atomenergi, Stockholm (Sweden). Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Feb 1971. 277p. Dep. NTIS (U. S. Sales Only).

Studies of selected redox equilibria were carried out as part of a program of research on the thermodynamics of mass-transport, deposition, and corrosion in water-cycle power plants. The theoretical part of the work was concerned with the evaluation of relevant electrochemical parameters and with the diagrammatic representation of these parameters. It has lead to a method for estimating equilibrium constants for aqueous systems at up to 374°C from free-energy and entropy data for 25°C and empirical equations for the heat capacities of ions. Diagrams were developed that illustrate the conditions of pe ($= E/RTF^{-1} \ln 10$) and pH or pO^{-2} obtaining at equilibrium in aqueous systems and in molten salts. The experimental part of the work was concerned with the development of methods and apparatus for electrochemical measurements on aqueous systems and molten salts. An autoclave was constructed, consisting of a heated cell in a cool pressure-vessel, that eliminates the corrosion and insulation problems occurring with conventional autoclaves. With one kind of cell the apparatus enables measurements on pseudo-reversible galvanic systems formed with, for example, one molal chloride solutions between pH 1 to 10, at temperatures up to about 250°C and under pressures up to about 40 atm. Electrodes formed with oxide/oxide and oxide/metal couples of iron, nickel, copper, silver, mercury, and antimony in moderately alkaline aqueous systems were studied up to 100°C. Only the HgO/Hg couple and, perhaps, the Cu_2O/Cu and the Ag_2O/Ag couples are likely to be useful in electrode systems. Measurements were made with the Cr(II)/Cr, Fe(II)/Fe, Co(II)/Co, Ni(II)/Ni, and Ag(I)/Ag couples in NaCl-$MgCl_2$ eutectic between 450 and 600°C. All the couples except the silver couple behaved reversibly and according to the Nernst equation when the activity of the electroactive cation was equated with its concentrations on the mole-fraction or ion-equivalent fraction scales. The silver couple behaved reversibly but the Ag^+-ion had an activity coefficient greater than unity. Accounts were prepared of some scientific meetings relevant to these studies that were held during 1967 and 1968, and of apparatus and methods used for high-temperature chemistry at the Technical University of Norway. (auth) (Sweden)

7170 EXPERIMENTAL STUDY OF THERMAL AND ELECTRICAL CONDUCTIVITIES OF TUNGSTEN AND MOLYBDENUM BY THE KOHLRAUSCH METHOD AT HIGH TEMPERATURES. Pepinov, R. I.; Nikol'skii, N. A. (Inst. of Energetics, Moscow). Heat Transfer - Sov. Res.; 3: No. 4, 135-46(Jul-Aug 1971).

Methods and experimental data are given for tungsten and molybdenum thermal conductivity and electrical resistivity in the temperature range of 400 to 2300°K. The experiments were conducted by pyrometry, using samples and an annular gap to simulate black-body conditions. A heat-loss compensating shield was also employed. The geometric characteristics of the calometric system were determined using the zone-method for calculating the total radiation. The data is in satisfactory agreement with published results. The Lorentz number for tungsten and molybdenum is calculated on the basis of the measured values. (auth)

7171 SELF-DIFFUSION IN FCC γ- AND BCC δ-CERIUM. Dariel, M. P. (Nuclear Research Centre, Beersheba, Israel); Dayan, D.; Languille, A. Phys. Rev., B; 4: No. 12, 4348-54 (15 Dec 1971).

The serial sectioning method was used to study self-diffusion in cerium metal. In the fcc γ phase, $D = 0.6e^{-36,600/RT}$ cm^2 sec^{-1}, and in the bcc δ phase, $D = 1.2 \times 10^{-2}e^{21,500/RT}$ cm^2 sec^{-1}. The diffusion parameters in the fcc structure are compatible with a normal vacancy mechanism. The high diffusivities and low activation energy in the bcc phase are characteristic of diffusion behavior in anomalous bcc metals. Similarities with self-diffusion in bcc ϵ-plutonium are stressed. (auth)

7172 MATERIALS SENSITIVE TO SLOW RATES OF STRAINING. Hartbower, C. E. (Aerojet-General Corp., Sacramento, Calif.). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 466, 115-47(1970).

From Symposium on impact testing of metals; Atlantic City, N. J. (22 Jun 1969).

In precrack Charpy slow-bend and impact tests of D6aC high-strength steel at 300 to 500°F, there was a reduction in slow-bend fracture energy as the test temperature was increased; whereas, there was an increase in impact fracture energy over the same temperature range. Thus, in high-strength steels, it is sometimes found that the precrack Charpy slow-bend and impact test results are approximately the same at room temperature, but attain a significant spread at moderately elevated temperature. In 6Al-4V titanium, the difference between slow-bend and impact was most pronounced at room temperature, again with the lowest fracture energy in slow bend; whereas, at 300°F, the slow-bend test indicated the material to be as tough or tougher than impact. In all-beta 3Al-13V-11Cr titanium in the solution-treated condition tested at room temperature, the slow-bend test result showed markedly higher toughness than impact, but, after aging, the slow-bend test result was appreciably lower than the impact value. Differences in fracture appearance attending slow versus impact rates of loading confirm these observations. The lower toughness in slow bending is believed to be the result of a combination of factors, including an adiabatic temperature rise in the plastic zone on impact, and time-dependent-embrittlement occurring in slow bending. In a material with a sharply defined transition curve at or about room temperature, it is easy to see how an adiabatic temperature rise in the plastic zone ahead of the crack could markedly increase the resistance to crack propagation. At the same time, it is well known that embrittlement involving a diffusion mechanism is not detected by impact testing; for example, hydrogen embrittlement and strain aging. In 6Al-4V titanium, the difference between slow-bend and impact at room temperature is consistent with a hydrogen-embrittlement mechanism involving maximum embrittlement at room temperature and a decreasing embrittlement at higher (and lower) temperatures. In D6aC steel, on the other hand, the loss of toughness in slow-bend occurs at moderately elevated temperature, which is consistent with spontaneous strain aging as a time-dependent embrittling mechanism. From these findings, it appears that the concept of strain-rate sensitivity should not be limited to the traditional interpretation that impact is the most severe test of a material. In a number of common structural metals, the materials are in fact more "sensitive" to slow rates of straining. (auth)

7173 LOW TEMPERATURE THERMAL PROPERTIES OF SOME INTERMETALLIC COMPOUNDS CONTAINING LANTHANIDES. Thompson, Alan Wetherbee. Pittsburgh; Univ. of Pittsburgh (1971). 145p. University Microfilms Order No. 71-23,668.

Thesis.

The heat capacities of several intermetallic compounds containing lanthanides were measured on an adiabatic calorimeter from 8 to 300°K. The compounds studied were LnBi and LnSb (Ln = La and Pr), $LnAl_2$ (Ln = Ce, Pr, Nd and Gd), and $LnCo_2$ (Ln = Ce, Pr and Nd). For the compounds PrBi, PrSb, and $CeAl_2$ in which the exchange energy is weak compared to the crystal field interaction, it was possible to determine the crystal field contribution to the heat capacity. The total splitting with the Γ_1 state as the ground state was found to be 280°K for PrBi and PrSb. These values were in good agreement with those determined by magnetic and neutron diffraction measurements. The total splitting for $CeAl_2$ (Γ_7 ground state) was found to be 76°K as determined from the maximum in the crystal field heat capacity, however the crystal field heat capacity deviated from the calculated heat capacity over most of the region. This may be because of the Kondo interaction that appears in this compound. For $PrAl_2$, $NdAl_2$, and $NdCo_2$ the crystal field interaction was comparable to the exchange. The heat capacities for these compounds showed an overlap of these two effects that was not possible to resolve. The Curie points determined from the heat capacities for these compounds, 31.8, 77.2, and 98.4°K, respectively, agreed with those determined from magnetic and resistivity measurements. The heat capacity of $NdCo_2$ showed an additional sharp peak at 41.5°K. The reason for this peak is not known. The heat capacity of $GdAl_2$ showed a long drawn out anomaly instead of λ-type anomaly that is generally associated with magnetic transitions. The peak in the heat capacity occurred at 150°K which agreed with the Curie point determined from magnetic measurements. The heat capacity for $PrCo_2$ also showed two anomalies, a sharp peak at 39.2°K and a rounded one at 43.5°K. The reason for the rounding was not clear, although the temperature of the maximum agreed with the temperature of the Curie point determined from magnetic data. An automatic data acquisition system for the calorimeter is also described. The system employed two digital voltmeters (DVM), one reading the voltage across a platinum resistance thermometer and the other simultaneously reading the voltage across a standard resistor. This method has the advantage of removing power supply and DVM (using a special calibration procedure) variations from the temperature calculations. The DVMs are switched to the heater circuit at the beginning of the heating period for the determination of the energy input. The sequence of operation and programming the DVMs are governed by a Master Control. The binary coded decimal data from the DVMs are read into a shift register memory. The data are then transferred to a printer and a card punch. Schematics are included for equipment constructed. The schematic for a solid state shield power supply with a simplified anticipation circuit is also included. (Diss. Abstr. Int., B)

7174 DIFFUSION OF ^{113}Sn AND ^{125}Sb IN LIQUID TIN AND ^{114}In IN LIQUID INDIUM OVER EXTENSIVE TEMPERATURE RANGES. Foster, John Paul. Philadelphia; Drexel Inst. of Tech. (1971). 232p. University Microfilms Order No. 71-23,955.

Thesis.

The capillary-reservoir technique has been used to study the diffusion of ^{113}Sn and ^{125}Sb in liquid tin from 655 to 1746°K, and the self-diffusion of ^{114}In from 621 to 1378°K. Multichannel scintillation radiotracer analyses were used to determine the total amount of diffusate migrating either into or out of a capillary tube. The diffusion data did not fit any of the available theoretical models over the complete temperature range, nor any empirical relations of the form $D = AT^n$. The observed nonlinear variation of log D versus T was correlated with the disappearance of a second structure in the liquid state Sn, and was confirmed by existing x-ray diffraction data. A definite wall effect was observed for ^{114}In at 775°K. On the basis of the broad temperature range diffusivity data obtained, experimental criteria were established for very accurate measurement of liquid metal diffusivities using the capillary reservoir technique. (Diss. Abstr. Int., B)

7175 INFLUENCE OF ALLOYING ELEMENTS ON THE MECHANICAL PROPERTIES OF WELDED JOINTS IN ALLOYS OF THE Ti–Al–Cr AND Ti–Al–Cr–Mo SYSTEMS. Khorev, A. I. Svar. Proizv.; No. 8, 29-32(Aug 1970). (In Russian).

Eight compositions of the two types of Ti alloy and their TIG-welded joints, with a constant 3% Al content and additions of up to 18% Cr and 15% Mo were studied, using various heat-treatment techniques. Alloys simultaneously alloyed with Cr and Mo had greater mechanical strength than those alloyed only with Cr. The increase in strength was combined with a decrease in the ductility of test specimens which was related to a higher degree of α-phase saturation of the weld rapidly cooled from high temperature and the formation of intermetallic $TiCr_2$. No significant improvements in mechanical properties could be obtained from simultaneous alloying of a β-type alloy VT15 with additions of Mo, V, Cr, and Fe, and a marked segregation of the alloying elements was observed. (Metals Abstr.)

7176 DEFORMIRUEMOST' METALLOV I BINARNYKH SPLAVOV. (Deformability of Metals and Binary Alloys). Tikhonov, A. S.; Osipov, V. G.; Bulat, S. I. Moscow; Izdatel'stvo Nauka (1971). 132p.

The resistance to deformation and the ductility of a number of metals and their alloys are discussed with respect to physicochemical factors such as the position of the elements in the periodic table, chemical and phase composition, and grain size. Attention is focussed on the thermomechanical parameters: previous history of stress, temperature, rate, and degree of deformation of the sample. One chapter is devoted to a study of the methods used in determining deformation and ductility. For purposes of comparison, the metals under consideration are divided into the following groups: the iron group, with Fe, Co, Ni, and Mn; the light non-ferrous group, with Al, Mg, and Be; the heavy non-ferrous group with Cu, Zn, Sn, and Pb; the refractory group, with Ti, Zr, V, Ta, Cr, Nb, Mo, W, and Re; the alkalies and alkaline earths, and the heavy radioactive metals of Th, U, and Pu. For the latter, the temperature ranges for given lattice structures, the characteristic ductility, the resistance to deformation with pertinent parameters are given. (303 references) (K.S.W.)

7177 CREEP STRENGTH VALUES WITH LOADS UP TO 1000 HOURS AND TEMPERATURES BETWEEN 300 AND 700°C AS WELL AS OXIDATION PHENOMENA OF SOLDERED JOINTS OF HIGH-TEMPERATURE MATERIALS. Colbus, J. (Univ., Saarbrucken, Ger.). Metall; 25: No. 10, 1103-9(Oct 1971). (In German).

Soldered joints were studied for five different types of high-temperature solder on five different types of high-temperature materials. Creep strength was determined for temperatures ranging from 500 to 700°C and for stress times up to 1000 hours. Data are presented in double logarithmic diagrams. Fine structure and various phases of the solder are discussed. In addition, experiments were performed on the effects of oxidation on solder and the resulting diminution of the soldering surface. (H.B.G.)

7178 APPROACH TO DETECTING THE BRITTLE TRANSITION TEMPERATURE OF STEELS BY MEANS OF HARDNESS TESTING AND ITS APPLICATIONS. Sato, Sennosuke (Ibaraki Univ., Hitachi, Japan); Oku, Tatsuo. Bull. JSME (Jap. Soc. Mech. Eng.); 14: No. 73, 605-14(Jul 1971).

A new nondestructive approach to measuring the brittle transition temperature of several steels by means of hardness testing is described. The transition temperature in hardness tests is defined as the intersections of the two straight-lines in the plot of the logarithmic Vickers hardness vs the reciprocal of absolute temperature. The transition temperatures of hardness are discussed in comparison with the results of the usual tensile test and a specially instrumented Charpy impact test. It was concluded that the first and second transition temperatures of hardness were equivalent to the ductile transition temperature and brittle transition temperature respectively. The approach has been applied effectively as surveillance measures of distributions of brittle transition temperatures of pre-strained welded steel plates, and increases of the nil ductility transition temperature due to neutron irradiation for nuclear reactor vessel steels. (auth) (Japan)

7179 WELDING OF THIN SHEET MOLYBDENUM. D'yachenko, V. V.; Morozov, B. P. Avtomat. Svarka; No. 7, 24-6 (Jul 1971). (In Russian).

Welding of thin sheet Mo involves high heating/cooling rates and large temperature gradients. The effects of welding speeds and techniques on the crystal character were studied in connection with alloy specimens 0.5 to 0.8 mm in thickness. The ductility of such seams depends on the orientation and form of the crystal boundary in the joint. A rate of 40 m/hr resulted in satisfactory ductility in argon-arc welding. (K.S.W.)

7180 CHARACTER OF PRESSURE VARIATION DURING THE EXPLOSION OF METAL POWDER. Ioffe, V. G. (Inst. of Steel and Alloys, Moscow). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 5, 425-6(May 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR.; 10: No. 5, 100-2(May 1971).

Studies were made on the explosibility of powdered Zr and a Ti–Zr-base alloy. The pressure was measured by means of an oscillograph and strain gages attached to an elastic membrane exposed to the explosions. The results showed that explosions of metal powders differ from gas explosions, in which the mixture temperature substantially rises and the reaction rate constant sharply grows. In the case of metal powders, the rate of pressure buildup attains a maximum at the very beginning of the explosion, before the safety devices have had time to open. The difference in kinetics between metal dust and gas explosions means that, in dealing with the former hazard, it is necessary to employ safety devices acting more rapidly and opening larger vents, and also to ensure that the design of equipment in which metal powder explosions are likely to occur meets more stringent strength specifications. (P.C.H.)

7181 METALLOCHEMISTRY OF BERYLLIDES. Samsonov, G. V.; Sinel'nikova, V. S. pp 288-93 of Metallovedenie. Struktura i Svoistva Stalei i Splavov Metallidy Novye Metody Issledovaniya. /Ageev, N. V. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Symposium on metallurgy and metallography; Moscow, USSR (14 May 1968).

The structure and properties of beryllides were examined with respect to the formation of stable electron configurations in the solid state. The following classes of Be compounds are suggested based upon chemical bond types: iono-covalent (alkali metals), covalent-metallic (beryllides of the Cu and Zn subgroups, rare-earth and transitional elements), and covalent (Be with non-metals and half-metals). (tr-auth)

7182 STUDY OF WORK SOFTENING IN POLYCRYSTALLINE METALS. Longo, Waldimir Pirro e. Gainesville, Fla.; Univ. of Florida (1970). 260p. University Microfilms Order No. 71-24,433.

Thesis.

Studies were made on the effects of work softening on the plastic behavior of polycrystalline metals. Temperature change tests were conducted on the high stacking fault metals—aluminum, copper, lead, molybdenum, nickel, and silver—as well as on the aluminum alloy 6061 under different conditions of heat treatment. Work softening was observed in all of them, provided the prestrain was introduced at sufficiently low temperatures to inhibit dynamic recovery and reloading was performed at a temperature favorable for dynamic recovery. Work softening was also obtained in aluminum at 298°K during straining at a slow strain rate after pre-loading at a higher strain rate. Temperature change tests carried on the low stacking fault energy alloy 70-30 α brass failed to produce work softening. Work softening experiments were successfully conducted in a mild steel pre-strained in the dynamic strain aging temperature range and reloaded at room temperature. This result was considered as evidence that strain aging inhibits dynamic recovery. The changes in the dislocation structure accompanying work softening were observed using electron microscopy techniques. Thin foils cut from nickel specimens deformed respectively at the pre-straining and reloading temperatures were examined. The dislocation structures observed were then compared to those resulting from work softening. It was concluded that during work softening the complex low temperature dislocation structure was replaced by a cell structure characteristic of deformation at a higher temperature. The evidence was that the dislocations rearranged themselves in order to mutually cancel their long range stress fields. The mechanisms responsible for the rearrangements were believed to be thermally activated cross-slip and climb. These mechanisms were also thought to promote some annihilation of dislocations of opposite sign. The drop of load, the flow stress to continue deformation, as well as the loss in tensile ductility which invariably results from work softening are discussed in terms of such rearrangements. For low stacking fault materials like 70-30 α brass, climb and cross-slip are difficult processes. As a result, dynamic recovery and cell structure formation are hindered. This is believed to explain the small temperature dependence of the work hardening rate and the absence of work softening in such materials. The effects of reloading at a lower temperature, metals previously strained at a higher temperature, were also investigated. Copper and nickel were tested and thin foils of the latter were observed in the microscope. This study indicated that the high temperature pre-strain does not affect the normal work hardening behavior of these metals at the lower temperatures. Consequently, a large increase in tensile ductility was obtained. In the electron microscope it was observed that the pre-strain cell structure was replaced during reloading by a structure equivalent to that obtained during deformation conducted entirely at the reloading temperature. (Diss. Abstr. Int., B) (TSS)

7183 CORROSION PROPERTIES OF GALVANIC COATINGS OF ZINC AND CADMIUM ALLOYS. Livshits, A. B.; Loshkarev, Yu. M.; Garbuzov, N. V.; Gladshteyn, A. Ya.; Lugovaya, V. A. Zashch. Metal.; 5: No. 6, 643-6(1969). (In Russian).

A study was made of the corrosion resistance of protective binary galvanic alloys based on Zn and Cd in conditions simulating industrial, tropical, and maritime atmospheres. The best results were given by 80% Cd–20% Zn alloy, and Cd–Zn coatings are recommended for use in place of Zn and Cd coatings for protection of parts in maritime and industrial atmospheres. The point of contact between the alloy and stainless steel does not require additional protection. (Referativnyi Zh.)

7184 RAPID MEASUREMENT OF THERMAL DIFFUSIVITY USING A MODULATED ELECTRON BEAM. Wheeler, M. J. (General Electric Co. Ltd., Wembley, Eng.). J. Sci. Technol. (London); 38: No. 3, 102-7(1971).

The modulated electron beam equipment, originally developed to determine the thermal diffusivity of a potential nuclear fuel material above 1200°K, can be used for measurements on very small specimens of most solid materials in the range of 500 to 3200°K. The principles and theory of the method are discussed and the equipment is described. Typical results are given for Ta and for UO_2. Reference is made to future developments. (UK)

7185 ADSORPTION, NUCLEATION, AND GROWTH OF CADMIUM ON TUNGSTEN COVERED WITH OXYGEN OR HYDROGEN. Voorhoeve, R. J. H.; Wagner, R. S. (Bell Telephone Labs. Inc., Murray Hill, N. J.). Met. Trans.; 2: No. 12, 3421-32(Dec 1971).

The effects of the adsorption of hydrogen and oxygen on the growth of cadmium from the vapor onto polycrystalline tungsten were studied. It was found that hydrogen does not affect the growth behavior in any way. Oxygen, on the hand, drastically diminishes the chemisorption of cadmium on tungsten and inhibits growth. Appreciable supersaturation is needed to induce nucleation and growth on oxidized tungsten. Oxygen prevents epitaxial growth, leading instead to formation of small, irregularly oriented islands and of a few whiskers. Experimental results on the kinetics and topography of the deposition were compared with nucleation theory. (auth)

7186 EFFECT OF PREFERRED ORIENTATION ON THE DAMPING CAPACITY OF MAGNESIUM ALLOYS. Schwaneke, Alfred E.; Nash, Robert W. (Rolla Metallurgy Research Center, Mo.). Met. Trans.; 2: No. 12, 3453-7(Dec 1971).

The torsional vibration damping of Mg−4.5 Ce alloys was correlated with the texture orientation resulting from the method of fabrication. Forged and forged-plus-swaged alloys at vibratory stress levels of 1500 psi exhibited specific damping capacities, respectively, of 6 and 11 times that of an extruded alloy of similar composition. Pole figures showed that the basal planes are oriented preferentially in the extruded alloys with a 20° tilt to the axis of the extrusion, while the basal planes are generally parallel to the rod axis for forged or forged-plus-swaged alloys. The correlations indicated that the major source of damping in these hexagonal magnesium alloys is stress-induced anelastic shear on the basal planes (probably by dislocation motion). (auth)

7187 PREDICTION OF ACTIVATION ENERGIES FOR CREEP AND SELF-DIFFUSION FROM HOT HARDNESS DATA. Sherby, O. D. (Stanford Univ., Calif.); Armstrong, P. E. Met. Trans.; 2: No. 12, 3479-84(Dec 1971).

It is shown that the activation energy for creep or self-diffusion for pure metals can be determined from hot hardness data above 0.75 T_m by means of the expression $H/E = G \exp Q_L/nRT$. Here H is the hot hardness, E is the elastic modulus, G is a material constant, Q_L is the lattice self-diffusion activation energy, R is the gas constant, T is the absolute temperature, and n is the stress exponent for creep assumed equal to five. Hot hardness data above 0.5 T_m plotted as logarithm H/E against reciprocal absolute temperature reveal two straight lines with a break observed at about 0.75 T_m. It is shown that the break occurs at a value of strain rate, $\dot{\epsilon}$, over lattice self-diffusivity, D_L, of about 10^9, a value associated with power-law breakdown for creep. These observations suggest two conclusions regarding the rate-controlling process during hot indentation testing of pure metals. Between 0.75 and 1.0 T_m, the deformation process is associated with lattice self-diffusion and creep flow in the power law region. Between 0.5 and 0.75 T_m the rate-determining process is associated with dislocation pipe diffusion and creep flow in the power-law breakdown region. (auth)

7188 EQUATION OF STATE FOR POROUS METALS UNDER STRONG SHOCK COMPRESSION. Naumann, Robert J. (Marshall Space Flight Center, Huntsville, Ala.). J. Appl. Phys.; 42: No. 12, 4945-54(Nov 1971).

An equation of state is developed for metals in the high-pressure high-temperature region that can be extended in a thermodynamically consistent manner to the vapor phase. The constants are obtained from observed thermodynamic properties and are specified for Al, Fe, Cu, Ni, Pb, and W. This equation of state was checked against experimental data by computing the Hugoniot curves for normal and porous samples for cases where experimental data are available. Also, the velocity of sound and release isentropes were computed for various shock conditions. (auth)

7189 ANODIC OXIDES OF Ta–Al ALLOY FILMS. Muth, D. G.; Sitarik, J. P. (Bell Telephone Labs., Allentown, Pa.). J. Appl. Phys.; 42: No. 12, 4941-4(Nov 1971).

The anodic oxides formed on two Ta alloy films with 23 at. % Al and 45 at. % Al are compared with anodic Ta_2O_5. The alloy films were obtained by cosputtering Ta and Al. A number of the oxide properties investigated depend on the Al concentration. The refractive index and dielectric constant vary as predicted for a homogeneous mixture of Ta_2O_5 and Al_2O_3, while the differential field strength and breakdown voltage increase in proportion to the Al_2O_3 content. For the anodization conditions and the electrolyte used in this study, the refractive index, dielectric constant, and differential field strength are independent of anodization voltage, and the stoichiometry of the two alloy compositions studied is maintained in the oxides. (auth)

7190 DIFFUSION OF Ag, Cd, In, Sn, AND Sb IN MAGNESIUM. Combronde, J.; Brebec, G. (CEN, Saclay, France). Acta Met.; 20: No. 1, 37-44(Jan 1972). (In French).

The impurity diffusion of Ag, Cd, In, Sn, and Sb in magnesium single crystals has been investigated along the c axis and perpendicular to it. Anisotropies were found to be weak except for silver. Experimental data display a valence effect on the activation energy measured along c axis: the latter increases with the solute atom valence except for antimony for which there is a strong discontinuity in the diffusion constants. The Lazarus and Le Claire model cannot explain the experimental data independently to the potential used. (auth)

7191 SINGLE-CRYSTALLINE ELASTIC CONSTANTS OF AuZn AND YZn. Schiltz, R. J. Jr.; Prevender, T. S.; Smith, J. F. (Ames Lab., Iowa). J. Appl. Phys.; 42: No. 12, 4680-4(Nov 1971).

The elastic constants of single crystals of cubic AuZn were determined over the temperature range 85 to 300°K and of cubic YZn over the temperature range 4.2 to 300°K. The anisotropy ratio of AuZn increases with decreasing temperature and exceeds a value of 9 prior to a martensitic phase transformation which occurs near 60°K for alloys of this stoichiometry. In contrast, the anisotropy ratio of YZn remains constant at 1.95 independent of temperature. Extrapolation of the elastic constants of YZn to 0°K allows evaluation of a Debye temperature of $\Theta_0 = 306.8$°K. (auth)

7192 THERMAL EXPANSION OF LEAD–TIN AND LEAD–CADMIUM ALLOYS. Balasundaram, L. J.; Sinha, A. N. (National Metallurgical Lab., Jamshedpur, India). J. Appl. Phys.; 42: No. 12, 5207(Nov 1971).

Thermal-expansion coefficients of low-melting lead−tin and lead−cadmium alloys were measured in the temperature range from room temperature to 125°C. In the two-phase region of the alloys, the simple rule of mixtures is applicable and there is good agreement between calculated and measured values. (auth)

7193 DENSITIES OF Fe–Ni, Co–Ni, Co–Mo, AND Co–W ALLOYS IN LIQUID STATE. Watanabe, Shunroku (Tohoku Univ., Sendai); Amatatu, Masayosi; Saito, Tunezo. Trans. Jap. Inst. Metals; 12: No. 5, 337-42(Sep 1971).

Studies were made on the physical properties of Fe−Ni, Co−Ni, Co−Mo, and Co−W alloys in the liquid state. Density measurements were made by the maximum bubble pressure method at temperatures between the melting points and 1660°C. It was found that the molar volume of Fe−Ni and Co−Ni alloys did not indicate the behavior of ideal mixing, and the molar volume of Co−Mo and Co−W alloys increased with increasing concentrations of Mo and W. On the basis of the coefficients of volume expansion of the alloys and electric resistance, the structures of Fe−Ni and Co−Ni alloys in the liquid state are discussed. (auth)

7194 ROLLING WORKABILITY OF PURE TUNGSTEN SINGLE CRYSTALS WITH (110)[001] AND (001)[110] ORIENTATIONS AT ROOM TEMPERATURE ~200°C. Ohba, Yukio; Tamura, Yoshio; Fujii, Tadayuki (National Research Inst. for Metals, Tokyo). Trans. Jap. Inst. Metals; 12: No. 5, 348-54(Sep 1971).

Pure tungsten single crystals with (110)[001] and (001)[110] orientations were grown by the technique of electron-beam zone-melting. Deformation by rolling in these orientations was studied in the temperature range between room temperature and 200°C. The (001)[110] crystal showed good ductility on rolling above 100°C, but the (110)[001] crystal was fractured in a brittle manner even at 200°C. An abnormal widening, which has not been observed in crystals of pure iron and 3% Si−Fe on rolling at room temperature, was found in the (001)[110] crystal rolled at 200°C. The (110)[001] crystal rotated about the transverse direction as in a 3% Si−Fe crystal with the same orientation. However, the degree of crystal rotation by rolling was found to be smaller at least up to 50% reduction, as compared with that of the 3% Si−Fe crystal. The above phenomena are discussed relating to the easiness of the multiple slip in tungsten crystals. (auth)

7195 SINTERED NICKEL–CHROMIUM–MOLYBDENUM ALLOYS. I. SINTERABILITY, PHYSICOMECHANICAL PROPERTIES, AND MICROSTRUCTURE. Solonin, S. M.; Chernyshev, I.; Fedorchenko, I. M.; Perepelkin, A. V.; Dzykovich, I. Ya. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 6, 453-7(Jun 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 6, 29-34(Jun 1971).

Properties and microstructures of sintered Ni−Cr−Mo alloys are discussed. It is noted that alloys in this system containing more than 15% each of Cr and Mo are characterized by intermetallic precipitation at grain boundaries. The alloy Ni−15% Cr−15% Mo sintered at 1200°C has greater strength than any other percentage composition in this system. (J.R.D.)

7196 TRENDS IN REACTOR USE OF PC STEEL MATERIALS. Tomioka, Hiroyuki (Shinko Wire Co. Ltd., Amagasaki, Japan). Tokushuko; 20: No. 2, 40-6(Feb 1971). (In Japanese).

Prestressed concrete (PC) is widely used at present for pressure vessels and containment vessels in nuclear reactors in Europe and the United States, because of its high economy and safety. Developments in reactor PC structures and trends in steel materials for PC structures including stabilized PC steel are reviewed. Advantages of the PCPV compared with steel vessels are high stability, good workability, and low cost. Requirements for the PC steel material include low relaxation at about 50°C and stabilized steel quality. The PC steel is stabilized to remove residual stress from cold-worked material having high strength, by heating under tensile stress. Advantages of the stabilized PC steel are the following: uniform load-elongation characteristics with high elastic limit; low relaxation; and superior straightness, making for ease of handling. (Japan)

Structure and Phase Studies

Refer also to abstracts 7742 and 7750.

7197 (UJV–2504–M) MICROSTRUCTURE AND DISTRIBUTION OF SECONDARY PHASES IN URANIUM AND ITS ALLOYS. Kocik, J.; Pav, T.; Otruba, J.; Saxl, I. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). May 1971. 79p. (In Czech). Dep. NTIS (U. S. Sales Only).

The dependence of the microstructure and the distribution of secondary phases in reactor grade α-uranium as well as U–Fe–Al and U–Fe–Al–Si alloys on the conditions of thermal treatment have been studied using optical metallography. Several characteristic morphological types of precipitated particles have been observed and their optimal etching conditions found. The hypothetical model based upon the concept of thermally activated growth of martensite is presented to explain the structures observed after quenching from γ. The grain morphology is also briefly discussed. (auth)

7198 PHASE TRANSITIONS IN THIN FILMS OF TUNGSTEN AND MOLYBDENUM. Gladkikh, M. T.; Protsenko, I. Yu.; Khotkevich, V. G. (Kharkov State Univ.). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 7, 656-9(Jul 1971). (In Ukrainian).

Phase diagrams for thin films of tungsten and molybdenum were plotted and on the basis of their analysis the differences of surface energies and heat were calculated according to transitions: amorphous (a) phase → fcc, a → bcc, and fcc → bcc. (auth)

7199 RECRYSTALLIZATION OF METALLIC MATERIALS. Papers Presented at a Seminar of the Institut fuer Metallkunde of the University of Stuttgart and the Max-Planck-Institut fuer Metallforschung, Stuttgart, During Summer 1970. Haessner, Frank (ed.). Stuttgart; Dr. Riederer Verlag GmbH (1971). 357p.

Current aspects of crystallization technology are discussed. Information is included on nucleation and kinetics involved in recrystallization, secondary recrystallization, effects of trace impurities, deformation effects, two-phase alloys, textures, and fabrication of special products. (J.R.D.)

7200 TOOLS AND TECHNIQUES IN PHYSICAL METALLURGY. VOLUME 2. Weinberg, F. New York; Marcel Dekker, Inc. (1970). 369p. $23.50.

The principles of techniques used in physical metallurgy are described along with application of these techniques. Information is included on electron microscopy, field-ion microscopy, thermionic-emission microscopy, electron-probe microanalysis, emission spectrography, and atomic absorption spectrophotometry. (J.R.D.)

7201 PROBLEM OF POLYMORPHIC METALS AND ALLOYS. Savitskii, E. M. pp 16-26 of Metallovedenie. Struktura i Svoistva Stalei i Splavov Metallidy Novye Metody Issledovaniya. /Ageev, N. V. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Symposium on metallurgy and metallography; Moscow, USSR (14 May 1968).

A brief survey of polymorphism in metals is presented, with a list of 30 polymorphic metals which includes many of the transuranium elements. The temperature of polymorphic conversion and crystal structure at high, intermediate, and low temperatures is tabulated for the 30 metals. The effects of alloying additives on the stabilization of polymorphic modifications are summarized for Fe, Ti, Ce, U, and Pu. The internal friction of U as a function of temperature is discussed and shown graphically, as is also the plasticity of U. The 9 polymorphic metals which are also superconductors are listed and some correlations are offered. (K.S.W.)

7202 INVESTIGATION OF INTERMETALLIC PHASES FORMED FROM TRANSITION METALS OF GROUPS IV–VIII. Bokii, G. B.; Grigor'ev, A. T.; Sokolovskaya, E. M.; (and others). pp 311-15 of Metallovedenie. Struktura i Svoistva Stalei i Splavov Metallidy Novye Metody Issledovaniya. /Ageev, N. V. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Symposium on metallurgy and metallography; Moscow, USSR (14 May 1968).

From a study of 40 binary metal systems about 30 intermetallic phases were found and used as the basis for rules for determining the physicochemical interaction of such metals. Using physicochemical analytical techniques, the interstitial phases and areas of homogeneity were investigated in binary and ternary systems of the transition metals. The effects of a third component on the binary intermetallic compound were of interest in a number of cases. A division of the transition metal systems into five groups is proposed, according to the coordination number of atoms in structures of pure components. Such a division allows certain assumptions to be made regarding interstitial phase types, conditions of their formation, and various features of phase diagrams. A series of experimental confirmations of the proposed classification were made. Phase diagrams are given for ternary alloys containing Nb, Ta, Mo, V, W, Zr, and Hf. (tr-auth)

7203 METHOD OF DIFFUSED LAYERS IN STUDYING THE PHASE DIAGRAM OF A TERNARY SYSTEM. Ivanov, O. S.; Tregubov, I. A.; Kuzina, L. N.; Borovskii, I. B.; Marchukova, I. D. pp 498-505 of Metallovedenie. Struktura i Svoistva Stalei i Splavov Metallidy Novye Metody Issledovaniya. /Ageev, N. V. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Symposium on metallurgy and metallography; Moscow, USSR (14 May 1968).

The effects of a strictly diffused layer on a phase diagram were studied. For the growth of an intermediate phase in a diffused layer, a significant gradient of chemical potential was essential. In three or more component diffusion layers the change in chemical and phase composition was more complexly associated with the phase diagram than in the case of a binary system. Three isothermal sections of the phase diagram of the W–Ta–Re system are used in the discussion. (K.S.W.)

7204 PHASE COMPOSITION OF IRON–ALUMINUM JOINTS ALLOYED WITH HOLMIUM. Ryabov, V. R.; Zarechnyuk, O. S.; Pabkin, D. M.; Vuvchar, O. I. Avtomat. Svarka; No. 7, 76-7(Jul 1971). (In Russian).

The isothermal section of the ternary system Al–Fe–Ho within the limits 0 to 33.3% Ho was studied at 500°C using x-ray and microscopic analyses. Seven phases were found in this region, four of which were ternary compounds, and three were binary. Suggested formulas which represent certain phases are: $HoFe_2Al_{10}$, $HoFe_{4.0\rightarrow5.3}Al_{8.0\rightarrow6.7}$, $HoFe_4Al_8$, $Ho_2Fe_{11}Al_6$, Ho_2Fe_{17}, HoFeAl, and $HoAl_2$. (K.S.W.)

7205 SOME REMARKS ON THE DEFORMATION TEXTURES OF TUNGSTEN. Rieck, G. D. (Eindhoven Technical Univ., Netherlands). Met. Trans.; 2: No. 12, 3495-6(Dec 1971).

The relation of the cylindrical texture to the rolling texture of tungsten sheets is discussed. The fiber texture of drawn tungsten wires has a certain asymmetry which can be understood if the electromicroscopic evidence about the fiber-shaped crystallites in the tungsten wire is considered. It is stated that twisting will bring about different deviations of, e.g., the [110] lattice rows in different parts of the ribbon. The maximum deviation, e.g., in the [001] and the [110] direction also depends on the manner of bending and twisting. Therefore, the large spread in the [001] direction is not contradictory with the small thickness of the fibers in that direction. (P.C.H.)

7206 LATTICE SPACINGS AND STACKING FAULT PROBABILITIES IN Ag–Cd–In ALLOYS. Krishnan, R. G.; Gupta, R. K.; Rama Rao, P. (Banaras Hindu Univ., India). Met. Trans.; 2: No. 12, 3373-5(Dec 1971).

Lattice spacing values in ternary Ag–Cd–In alloys containing 5 to 30 at. % Cd and 5 to 15 at. % In were determined from x-ray powder patterns using the Nelson-Riley extrapolation procedure. The values were found to lie, in a ternary plot, on iso-parameter lines obtained by joining equal lattice spacing values in the relevant binary alloys. The intrinsic stacking fault probabilities (α) in these alloys obtained from measurement of x-ray peak displacements were found to follow the empirical relation $\alpha = \alpha_0 \exp k\,|\Delta Z|\,p$, where α_0 is the intrinsic fault probability in Ag, $|\Delta Z|$ is the weighted mean of solvent-solute valence differences, p is the combined solute content, and k is a constant approximately equal to 0.08 in agreement with the value found earlier for binary alloys based on silver. (auth)

7207 ORDER–DISORDER TRANSFORMATION IN A Mg–25.7 AT. PERCENT In ALLOY. Hirata, Toshiya (National Research Inst. for Metals, Tokyo). Trans. Jap. Inst. Metals; 12: No. 5, 375-7(Sep 1971).

Calorimetric and dilatometric studies were made in order to obtain information on the order–disorder transformation in a Mg–25.7 at. % In alloy near the composition Mg_3In and to compare with the phenomenon in the Mg–Cd systems. The total energy change due to the order–disorder transformation was calculated to be 570 cal/mole for Mg–In. The experimental value of $RT_c/U\,(T_c)$ where R is the gas constant, T_c the transition temperature, and $U\,(T_c)$ the transformation energy obtained by integrating the anomalous specific heat from room temperature to just above T_c, was 2.19, which is in good agreement with the value calculated by the Bragg–Williams theory. The results showed that the transformation from order to disorder is accompanied by an expansion of about 0.3%. The activation energy for disordering was determined to be 30 kcal/mole. The specimen in the order state was a little harder than that in the disordered one. The

Vickers hardness obtained with the highly ordered specimen and the disordered one was 40 and 37, respectively. The disordered state corresponded to that quenched after keeping at 380°C for 1 hr. (P.C.H.)

7208 STRUCTURE OF ANTIMONY FILMS ON TUNGSTEN (110) SURFACES. Gorodetskii, D. A.; Yas'ko, A. A. (Kiev State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 5, 1085-8(Nov 1971).

Translated from Fiz. Tverd. Tela; 13: No. 5, 1298-1303(May 1971).

Low-energy electron diffraction was used to study the structure of thin antimony films on (110) tungsten surfaces. During antimony condensation onto the crystal at room temperature, two diffraction patterns appeared which had previously not been observed for metals on this surface. The coverage degrees corresponding to these patterns were 0.25 and 0.5, respectively. Increasing the antimony concentration lead to the formation of ordered films with coverage degrees 0.67 and 0.75. The latter structure transformed into antimony crystals oriented along the (100) surface with a pseudocubic lattice parallel to the substrate. The work function of these films was 4.7 eV. The effects of heating and cooling the crystal on the evaporated film structure were studied. The structural features of the monatomic films were compared with the nature of the antimony lattice bonding forces. (auth)

7209 MORPHOLOGY OF THERMAL ETCH PITS IN BERYLLIUM SINGLE CRYSTALS. Pugachev, N. S.; Papirov, I. I.; Tikhinskii, G. F.; Kornienko, L. A.; Nikolaenko, A. A. (Physical-Technical Inst., Kiev). Sov. Phys.-Cryst. (Engl. Transl.); 16: No. 3, 570-2(Nov-Dec 1971).

Translated from Kristallografiya; 16: No. 3, 657-9(May-Jun 1971).

A study was made of the morphology and density of etch pits resulting from the evaporation of 99 and 99.99% pure Be single crystals. Hexagonal etch pits were observed on the (0001) basal plane for all evaporation temperatures from 850 to 1200°C. The angle of slope of the wide faces varies nonmonotonically with the evaporation temperature, while their density increases with temperature. In high-purity crystals, the etch pits were located very irregularly on the surface and are more dense than on the lower-purity crystals. The evaporation mechanism is probably movement of shallow terraces along the close-packed (0001) and $(10\bar{1}0)$ planes. The density and morphology of etch pits depends on the dislocation structure and on the surface condition. (D.L.C.)

7210 COMPOSITION AND STRUCTURE OF CO-SPUTTERED Ta-Ti ALLOY THIN FILMS. Oohashi, Takashi; Yamanaka, Shun'ichi (Tokyo Inst. of Tech.). Jap. J. Appl. Phys.; 11: No. 1, 108-9(Jan 1972).

Ta-Ti alloy thin films were deposited by dc glow-discharge diode sputtering from Ta cathode targets partly covered by Ti plates. The Ti content could be controlled by adjusting the shapes and areas of the Ti plates. The dependence of structure on composition and deposition rate is shown in a diagram; in the Ti-rich region, the structure is hexagonal and has preferred (001) orientation which decreased with the deposition rate. As the Ti content decreased, first a cubic and then a tetragonal structure appeared. When the Ta content was >40 at. % and the deposition rate low, an amorphous structure appeared. (D.L.C.)

7211 SYSTEMS TITANIUM-TUNGSTEN-BORON, HAFNIUM-TANTALUM-BORON, AND TANTALUM-TUNGSTEN-BORON. Kuz'ma, Yu. B.; Svarichevskaya, S. I.; Telegus, V. S. (Lvov State Univ.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 6, 478-81(Jun 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 6, 61-5(Jun 1971).

Results of investigation are used in making a comparison of the systems Ta-Ti-B, Ta-Zr-B, and Ta-Hf-B. A common feature of these systems is the absence of ternary compounds and the formation of continuous series of solid solutions between the diborides. The solubility of the metals of group IVa in tantalum borides increases in passing from Ti to Hf. In spite of the fact that the atomic radii of Ti and Ta are almost identical, the solubility of Ti in Ta borides is much less than that of Zr or Hf. Thus, in the formation of solid solutions of the metals of group IVa in Ta borides, the position of the elements in the periodic system rather than the dimensional factor plays a decisive part. (auth)

Radiation Effects

Refer also to abstracts 7721 and 8545.

7212 NEUTRON RADIATION EFFECTS ON TANGENTIAL AND AXIAL ELASTIC LIMITS OF ZIRCOLOY-2 FUEL ELEMENT CLADDINGS. Boos, B.; Garzarolli, F.; Schoenfeld, H. (Kernenergieversuchsanlage, Grosswelzheim, Ger.). Atomwirt., Atomtech.; 16: No. 11, 574-5(Nov 1971). (In German).

Cladding samples were taken from spent fuel elements of a reactor. Limits in ductility were determined in the longitudinal direction as well as axially at 350°C. Moreover, thin samples were studied with an electron microscope. The electron microscopy tests showed that neutron radiation produced displacement rings which enhanced the resistance against sliding. The increase in ductility limits was more pronounced in the axial than in the tangential direction. Possible reasons for the effect are discussed. (H.B.G.)

Ceramics and Cermets

Preparation and Fabrication

Refer also to abstracts 6578, 7156, and 7162.

7213 URANIUM DIOXIDE BY THE ELECTROLYSIS OF MOLTEN CHLORIDES. Baraboshkin, A. N.; Puzakov, V. V.; Tarasova, K. P. Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial; No. 15, 81-8(1970). (In Russian).

A dense, complex deposit of UO_2 was obtained by electrolysis at 800°C of a molten mixture of alkali metal chlorides containing 30.0 wt % UCl_4. A series of electrolysis experiments produced UO_x, where x ranged from 2.00 to 2.21. Conducting the electrolysis in an atmosphere of dry HCl improved the stoichiometry of the product. Lowering the temperature of the electrolysis to 600°C lead to a significant reduction of the porosity of the deposited dioxide. (tr-auth)

7214 EFFECT OF UCl_4 ON THE ELECTROCRYSTALLIZATION OF UO_2 FROM MOLTEN CHLORIDES. Baraboshkin, A. N.; Kaliev, K. A.; Ksenofontova, T. B.; Tarasova, K. P. Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial; No. 15, 74-80(1970). (In Russian).

The effect of UCl_4 on the initial stages of electrocrystallization of UO_2 from the melt $LiCl-KCl-UO_2Cl_2$ was investigated at 400°C. The magnitude of the maximum overvoltage did not change, but the number of crystals forming decreased as a result of adding more UCl_4 to the melt. A drop-shaped form of the crystals corresponded to the dioxide, and was obtained at UCl_4 concentrations of not less than 0.3 wt %. Such a concentration may be obtained by treatment of the melt with dry HCl. (tr-auth)

7215 IMPROVEMENTS RELATING TO THE FABRICATION OF NUCLEAR FUEL PELLETS. (to Belgonucleaire SA). British Patent 1,252,408. 3 Nov 1971. Priority date 25 Feb 1969, Belgium.

A method is described for the fabrication of reactor fuel pellets, which involves the steps of pelletizing ceramic oxide nuclear fuel powder and sintering the pellets in a reducing atmosphere at a temperature above 1400°C. The final density of pellets is limited by adding a small proportion of an oxide of Ba or Sr or a compound of Ba or Sr to the fuel components before pelletizing, which gives rise to an oxide by thermal decomposition. The Sr or Ba compound may be added during any step of the fabrication, either during fabrication of the powder or during the treatment thereof before the pelletizing. (P.C.H.)

7216 URANIUM DIOXIDE ARTICLE AND METHOD OF PRODUCING THE SAME. Wyatt, Brian S. (to Atomic Energy of Canada Ltd.). U. S. Patent 3,609,095. 28 Sep 1971. Filed 24 Feb 1969.

A method is described for the production of uranium dioxide articles such as nuclear fuel elements and ceramic shapes and which comprise a powdered mixture of UO_{2+N} and U or Pu metal, wherein X is the amount of excess O_2 required to produce, from said mixture, stoichiometric UO_2 when subjected to reaction conditions under irradiation. One of the problems incidental to the use of nuclear fuel elements containing vibration packed mixtures of uranium dioxide (UO_2) powders is the shrinkage of the UO_2 that occurs at the high temperatures generated in the fuel element during irradiation. The maximum packed densities thus far obtained in nuclear fuel elements, made by vibration packing inside a metal sheath a mixture of different size fractions of UO_2 powders, are in the range of 88 to 92 percent of the theoretical density. The UO_2 powder is commonly prepared by crushing previously sintered or fused blocks of UO_2. During irradiation of such an element, the UO_2 powder tends to sinter with resultant shrinkage of the UO_2 body. This shrinkage could impair heat transfer between fuel and sheath and might eventually result in the collapse of the fuel-sheathing when this is insufficiently thick to be self-supporting in the reactor coolant pressure. (Official Gazette)

7217 MATERIAL MADE OF NUCLEAR FUEL ASSOCIATED WITH EXPANDED GRAPHITE. Slonina, Jean-Pierre; Maire, Jacques; Pernollet, Andre (to Societe le Carbone Lorraine). French Patent 2,061,499. 25 June 1971. Filed 4 Feb 1969. (In French).

A new material for nuclear reactors has been developed. It consists of nuclear fuel particles agglomerated by recompressed expanded graphite, a supple material with a good thermal conductivity being formed. The material can be produced in the form of thin ductile sheets, or in the form of large blocks (superposition of many thin sheets or an agglomeration of the thin sheets using a bonding material, which can be carbonized). (France)

7218 PREPARATION OF HAFNIUM–TANTALUM NITRIDE FILMS BY REACTIVE ALLOY SPUTTERING. Locker, L. D.; Naegele, C. L.; Vratny, F. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Electrochem. Soc.; 118: No. 11, 1856-62(Nov 1971).

Thin films of hafnium nitride and tantalum nitride with resistivities of 10^{10} and 10^4 ohm-cm, respectively, were deposited by rf + dc reactive sputtering. By sputtering hafnium-tantalum mixtures in pure nitrogen at 7.0×10^{-2} torr, the complete range of resistivities is obtained, with a linear increase between 10^5 to 10^9 ohm-cm, corresponding to a relative hafnium content of 40 to 70%. For a fixed Hf : Ta ratio, the resistivity, deposition rate, and nitrogen content of the films depend on the pressure and substrate temperature. For pure tantalum a dinitride (TaN_2) is deposited, but for pure hafnium the dinitride has not been obtained. An alloy nitride containing 60% Hf can be represented by the formula $Hf_{0.6}Ta_{0.4}N_x$, where x increases from 1.2 to 1.4 as the substrate temperature increases from 225 to 400°C. A sequence of reaction steps on the substrate surface is proposed to explain the deposition rates observed in reactive sputtering. (auth)

Properties Evaluations

Refer also to abstracts 7184, 7239, 7736, and 7751.

7219 (BNWL-SA-3818) HIGH-TEMPERATURE PHASE TRANSFORMATIONS IN SOME LANTHANIDE AND ACTINIDE OXIDES. Chikalla, T. D.; McNeilly, C. E.; Bates, J. L.; Rasmussen, J. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sep 1971. Contract AT(45-1)-1830. 35p. (CONF-710926-1). Dep. NTIS.

From International conference on high temperature phase transformations; Odeillo, France (30 Sep 1971).

The melting behavior of the actinide dioxides and sesquioxides from thorium through curium is reviewed. Melting points of two actinide oxides, heretofore unreported, were determined: NpO_2 melts at 2560 ± 50°C and Am_2O_3 melts at 2205 ± 15°C. High temperature phase transformations in Cm_2O_3, Pm_2O_3, and Sm_2O_3 were studied, and all three of these oxides exhibited five solid-state polymorphic modifications. The phase transformation behavior in the actinide sesquioxides is very similar to the lanthanide oxides, and the thermal stability domains of the various polymorphs in both series correlates well with the trivalent ionic radii. The volume change on melting in Sm_2O_3 was determined as 4.3%. Other properties of liquid Sm_2O_3 studied include surface tension and liquid expansion. (auth)

7220 DIFFUSION OF SEVERAL GASES IN VITREOUS BORON TRIOXIDE. Brandt, W. W.; Ikeda, T.; Schelly, Z. A. (Univ. of Wisconsin, Milwaukee). Phys. Chem. Glasses; 12: No. 5, 139-44(Oct 1971).

The desorption rates of helium, neon, argon, and deuterium from several samples of vitreous boron trioxide, B_2O_3, were measured at various temperatures, using a medium-resolution mass spectrometer. Diffusion coefficients and corresponding activation energies were obtained by comparing the experimental desorption rates with appropriate solutions of the diffusion equation. The diffusion coefficients of Ne and Ar were found to be distinctly higher than the corresponding values reported for other inorganic glasses, while those of He were more comparable. The results are discussed in terms of the random network structure and are compared to data previously obtained on zeolites. The D_2 desorption rates measured at high temperatures and long times were affected by a complication, presumably the exchange of D_2 with residual hydroxyl groups present. (auth)

7221 DIRECT MEASUREMENT AT 1300°C OF THE PARTIAL MOLAR ENTHALPY OF MIXING OF OXYGEN IN THE SYSTEM Zr–O FROM O/Zr = 0 TO O/Zr = 2. Boureau, G.; Gerdanian, P. (Univ. of Paris, Orsay, France). High Temp.-High Pressures; 2: No. 6, 681-93(1970). (In French).

The partial molar enthalpy of mixing of oxygen in the Zr–O system was directly measured at 1300°C from O/Zr = 0 to O/Zr = 2. The microcalorimeter of the Tian–Calvet type operating at 1300°C is briefly described, and the principles of measurement and of calibration are given. The conditions that must be satisfied in order that $h_{O_2}^M$ may be calculated from the measured heat quantities δq are discussed. In particular, it is necessary that the oxygen absorption is uniform over the exposed surface of the sample, and a criterion is established for verifying that this condition is fulfilled. Experimental values of $h_{O_2}^M$ are presented, and the precision of the measurements is discussed. (auth)

7222 THERMAL EXPANSION OF PORCELAIN ENAMELS CONTAINING CERIUM OXIDE. Nedeljkovic, Arsenije I.; Cook, Ralph L. (Univ. of Illinois, Urbana). Amer. Ceram. Soc. Bull.; 50: No. 11, 929-32(Nov 1971).

The contribution of cerium oxide to the thermal expansion of porcelain enamel glasses of a soda borosilicate type can be expressed between 25 and 400°C by the volume expansion factor, which is equal to $2.41 \cdot 10^{-7}/°C$. The expansion of the heat treated specimens was higher than that of the clear, transparent glasses of the same composition, the difference in expansion being proportional to the amount of CeO_2 crystals formed during heat treatment. Porcelain enamels containing cerium oxide have a lower thermal expansion than enamels containing TiO_2 or Sb_2O_5 because of the different behavior of Ce^{4+}, Ti^{4+} or Sb^{5+} ions in glasses. The replacement of Na_2O by Li_2O decreased the expansion in ceria-containing porcelain enamels. (auth)

7223 NITRIDE, CHROMIUM CARBIDE, AND TITANIUM CARBIDE SURFACE COATINGS FOR METAL-FORMING TOOLS. Ruppert, W. Draht-Welt; 56: No. 8, 453-9(Aug 1970). (In German).

A survey of surface coatings used to improve the performance of forming tools is presented. Nitriding of steels of the 2% C, 12% Cr type is discussed in detail and Cr and Ti diffusion processes which lead to the formation of their respective carbides are discussed. The properties of each type of coating are considered in detail. (Metals Abstr.)

7224 USE OF ZIRCONIA REFRACTORIES FOR LINING HIGH-TEMPERATURE INDUCTION FURNACES. Karaulov, A. G.; Rudyak, I. N.; Grushevaya, T. F.; Efimov, Yu. P.; Palashenko, V. I. Refractories (USSR) (Engl. Transl.); 12: No. 3-4, 169-73(Mar-Apr 1971).

Translated from Ogneupory; 12: No. 3, 32-6(Mar 1971).

A lining was prepared for zirconia (sectors) which permitted the induction heating of refractory alloy blanks up to temperatures of 2300°C in a protective atmosphere. The zirconia sectors placed in the working zones showed the maximum wear. The sectors failed due to splitting, cracking, and scaling of the working surface. The service life of the lining depends on the number of heatings of the blank, the variations in temperature, and the degree of cooling in the lining between heatings. It can be determined only by using refractories in industrial induction furnaces. (auth)

7225 STABILITY AND DEFORMATION OF ZrC, NbC, UC–UC_2, AND USi_2 AT HIGH TEMPERATURES. Gomozov, L. I.; Ivanov, O. S.; Dedyurin, A. I. pp 342-51 of Metallovedenie. Struktura i Svoistva Stalei i Splavov Metallidy Novye Metody Issledovaniya. /Ageev, N. V. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Symposium on metallurgy and metallography; Moscow, USSR (14 May 1968).

The compression of refractory compounds at temperatures up to 3,500°C was investigated. Two linearly connected parts were detected for studying the compounds in the coordinates ln g vs 1/T, and were connected with deformation mechanisms for such compounds of interest as ZrC, NbC – 0.58 T_{mp}, UC – 0.64, UC_2 – 0.68, and USi_2 – 0.72, T_{mp}. A change in the mechanism of deformation is caused by an increase in the diffusion mobility and transition of the compounds under study to a plastic state. An increase in the homologous temperature of transition in the series (ZrC, NbC) – UC – UC_2 – USi_2 is associated with an increase in the fraction of covalent and ionic components of bond energy of the crystal lattice, and also with an increase in the degree of symmetry for UC_2 and USi_2. For approximately equimolar solid solutions of refractory carbides a plastic deformation to destruction (0.2%) was observed only at temperatures >0.75 T_{mp}. (tr-auth)

7226 EFFECT OF COOLING RATE ON THE QUALITY OF HARD ALLOYS. Mukha, I. M.; Globa, L. V. (Radiopribor Factory, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 5, 418-20(May 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR.; 10: No. 5, 91-4(May 1971).

It was established that cooling rate has no effect on the hardness of hard alloys, such as WC–Co, but markedly affects their transverse rupture strength. Cooling rate is a factor influencing the magnetization intensity of hard alloys with high Co contents (15% or higher), which is evidence that the WC content of the Co component rises as a result of rapid cooling. (auth)

7227 CATALYTIC EFFECT OF HAFNIUM, TANTALUM, AND TUNGSTEN CARBIDE POWDERS ON THE REDUCTION OF NICKEL OXIDE. Klimak, Z. A.; Podchernyaeva, I. A.; Samsonov, G. V.; Fomenko, V. S. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 5, 356-8(May 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR.; 10: No. 5, 15-17(May 1971).

Studies were made on the effects of HfC, TaC, and Wc additions on the kinetics of the reduction of the lower nickel oxide with hydrogen. The results showed that the greatest acceleration in the reduction of NiO was attained at addition concentration of up to 4 vol %; increasing the amount of an addition above this value (up to 16 vol %) had no marked effect on the rate of the process. X-ray structural analysis of reduced specimens revealed no new phases other than metallic nickel and the additions themselves, which was evidence that the effects of the carbides on the NiO reduction process was a catalytic one. The results showed that, listed in order of increasing catalytic action in the reduction of NiO with H, the carbides form the series: HfC, TaC, and WC. (P.C.H.)

7228 SHAPE, STRENGTH, AND ABRASIVE POWER OF GRAINS OF REFRACTORY COMPOUND POWDERS. Bezykornov, A. I.; Bogomolov, N. I.; Gurinchuk, I. I.; (and others) (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 5, 397-400(May 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR.; 10: No. 5, 65-9(May 1971).

Studies on the shape, strength, and abrasive power of powders of fused TiC, NbC, and CaB_6 showed that the grains of NbC powders deviate from isometry to a greater extent than do the grains of TiC powders. At grain sizes in excess of 250 μ, the grain strength of TiC and NbC powders was higher than that of CaB_6 and white electrocorundum powders. At smaller grain sizes the reverse was true. The compressive and tensile strengths of the grains of refractory compounds were evaluated. Listed in the order of increasing abrasive power, the compounds investigated form the white electrocorundum series: $NbC : TiC : CaB_6 = 1 : 1.18 : 1.36 : 1.88$, the abrasive power of white electrocorundum used as unity. (P.C.H.)

7229 PLASTIC DEFORMATION OF CARBIDES DURING DIAMOND GRINDING. Samsonov, G. V.; Bozhko, S. A.; Kushtalova, I. P. Dokl. Akad. Nauk SSSR; 198: No. 1, 83-5(1 May 1971). (In Russian).

In order to demonstrate plastic deformation of the carbides of some transition metals of Groups IV and V, samples of Ti, Zr, and Nb carbides were synthesized and subjected to grinding to a depth of 0.03 mm. Under the conditions described, the temperature of the ground surface did not exceed 300 to 400°C, thus obviating a possible change in composition. Microhardness determinations and carbon analyses showed that Nb carbide exhibited the greatest plasticity. The density of dislocations in the three carbide samples was also studied as a function of the composition of the carbides. (K.S.W.)

7230 SILICIDE PRECIPITATION IN THE Ti–Zr–Al–Si SYSTEM. Flower, H. M.; Swann, P. R.; West, D. R. F. (Imperial Coll. of Science and Tech., London). Met. Trans.; 2: No. 12, 3289-97(Dec 1971).

Silicide precipitation was studied in a number of martensitic Ti–Si alloys and ternary and more complex alloys containing zirconium and aluminum. The precipitation was found to be strongly influenced by composition. Heterogeneous nucleation of Ti_5Si_3 occurs at, and above, 500°C in binary Ti–Si alloys containing up to 2.4% Si and little conventional precipitation hardening can be achieved. Zirconium additions are incorporated into the silicide and produces finer, more stable particle dispersions accompanied by an improved aging response. If critical concentrations of zirconium (approximately 5%) and silicon (approximately 1%) are present, matrix nucleation of Guinier–Preston (G.P.) zones occurs at, and below 550°C. This is accompanied by a significant aging response. Additions of aluminum reduce the rate of precipitate growth while having little effect on the nature of the precipitates produced. It was found that typical commercial heat treatments of "near α" silicon-bearing alloys (0.5% Si max) do not produce silicide dispersions. (auth)

7231 THERMODYNAMICS OF MELTS IN THE SYSTEM VO_2–V_2O_5. Suito, Hideaki; Gaskell, D. R. (Univ. of Pennsylvania, Philadelphia). Met. Trans.; 2: No. 12, 3299-3303(Dec 1971).

Using a gravimetric technique, the oxygen isobars in the liquid phase field of the system $VO_2-V_2O_5$ have been determined in the temperature range 1020 to 1100°C and in the oxygen pressure range 0.01 to 0.4 atm, and the VO_2 liquidus and solidus curves have been determined in the temperature range 953 to 1081°C. From these results have been calculated the activities of the components VO_2 and $VO_{2.5}$ in the system and the standard free energy change for the reaction $2VO_{2(s)} + \frac{1}{2}O_{2(g)} = V_2O_{5(l)}$. The latter was determined to be $\Delta G^0 = -17780 + 7.64T$ in the temperature range 1020 to 1100°C. (auth)

7232 THERMAL CONDUCTIVITY OF BeO SINGLE CRYSTALS. Slack, Glen A. (General Electric Research and Development Center, Schenectady, N. Y.); Austerman, S. B. J. Appl. Phys.; 42: No. 12, 4713-17(Nov 1971).

The thermal conductivities of three single crystals of BeO were measured from 2 to 300°K. Phonons carry the heat at all temperatures. At 300°K, the conductivity is 3.7 W/cm K, which is slightly less than that of copper. In the purest sample, the maximum conductivity occurs at 45°K where it is 137 W/cm k, and at temperatures below 10°K the conductivity is limited by boundary scattering. The anisotropy in the conductivity of this hexagonal material is 20% or less. (auth)

7233 EFFECT OF DOMAIN SIZE ON THE HARDNESS OF ORDERED $VC_{0.84}$. Hannink, R. H. J.; Murray, M. J. (Cavendish Lab., Cambridge, Eng.). Acta Met.; 20: No. 1, 123-31(Jan 1972).

It is now well known that $VC_{0.84}$ and some other substoichiometric compositions of this carbide exhibit ordering. As might be expected the order range depends to a very great extent upon the specimen's thermal history. A systematic study has been made to determine the effects of cooling rate through the order–disorder transition range on the domain structure and subsequent room temperature hardness. The hardness was found to be related inversely to the domain size. This result was analyzed in terms of existing theories for grain boundary and domain boundary hardening. Substructure within the domains also increased the hardness to a lesser extent. (auth)

7234 EFFECT OF TEMPERATURE ON THE WEAR AND CHARACTER OF RUPTURE OF TITANIUM AND NIOBIUM CARBIDES. Koval'chenko, M. S.; Tkachenko, Yu. G.; Pilyankevich, A. N.; Kryachenko, V. I. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 6, 488-91(Jun 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 6, 74-8(Jun 1971).

A study was made of the effect of temperature on the wear of titanium and niobium carbides. It was established that, within the whole temperature range investigated, the carbides exhibit excellent wear resistance. The maximum increase in wear intensity is observed in the range 500 to 1200°C. An electron-microscopic investigation was made into the character of rupture of the surface of niobium carbide under friction conditions in the range 20 to 1600°C. It was found that, at temperatures in excess of 1200°C, all signs of brittle rupture disappear from the surface layer. (auth)

Structure and Phase Studies

Refer also to abstract 6569.

7235 (LA-4742) EFFECTS OF SELF-IRRADIATION ON THE LATTICE OF $^{238(80\%)}PuO_2$. Roof, R. B. Jr. (Los Alamos Scientific Lab., N. Mex.). Oct 1971. Contract W-7405-eng-36. 16p. Dep. NTIS.

As a function of self-irradiation, the crystalline lattice of $^{238(80\%)}PuO_2$ is gradually altered. The technique of x-ray line broadening was used to search for changes in the crystallite size and strain in the lattice following an initial annealing treatment. The integral breadth, Fourier coefficient, and variance methods were used to analyze the broadening of the x-ray powder pattern lines. The mechanism of alteration appears to be one of retained strain as no evidence was forthcoming from these techniques to indicate that the material undergoes significant crystallite size change. The strain in the lattice changed from zero, at time zero, to approximately 0.2% during a two-year period. (auth)

7236 (ORNL-tr-2496) p–T–c DIAGRAM OF THE NIOBIUM–OXYGEN AND TANTALUM–OXYGEN SYSTEM. Fromm, Eckehard. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Z. Metallk.; 57: 540-5(1966). 14p. Dep. NTIS.

Gravimetric degassing curves of Nb and Ta containing oxygen in solution were evaluated assuming that only the volatile oxides NbO and NbO_2 or TaO and TaO_2 evaporate. The rate of evaporation of the volatile compounds was evaluated as a function of oxygen concentration and temperature of the α solid solutions. From these results the equilibrium partial pressures of the oxides and the α solid solution were determined and the p-T-c equilibrium diagrams of the metal-rich part of the Nb–O and Ta–O systems were established. (auth)

7237 NON-STOICHIOMETRIC VACANCY ORDER IN VANADIUM MONOXIDE. Bell, P. S.; Lewis, M. H. (Univ. of Warwick, Coventry, Eng.). Phys. Status Solidi (a); 7: No. 2, 431-9(16 Oct 1971).

An electron microscope study was made of the nominally cubic vanadium monoxide phase. Crystals of different composition varying over the whole phase field were grown by the floating zone and cold crucible methods. In oxygen-rich specimens, after low-temperature annealing, ordered domains of a tetragonal superlattice nucleate and grow in the cubic matrix. A partial phase diagram indicating the stability limits of the ordered phase, based on isothermal heat treatments, is proposed. For each of the three cubic orientations of the tetragonal domain c-axis, sub-domains of a tetragonal superlattice with large unit cell were found to exist in twin-related orientations. The reciprocal lattice and hence structure of the superlattice was found by electron diffraction combined with the dark-field imaging technique. The unit cell content is $V_{244}O_{320}$ and contains 20 tetrahedrally coordinated interstitial vanadium atoms as well as 96 vanadium vacancies. (auth)

7238 PHASE EQUILIBRIA IN THE TERNARY SYSTEMS TANTALUM–IRON–BORON AND TANTALUM–NICKEL–BORON. Kuz'ma, Yu. B.; Sobolev, A. S.; Fedorov, T. F. (Lvov State Univ. Inst. of Metallurgy, Moscow). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 5, 410-14(May 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR.; 10: No. 5, 81-6(May 1971).

X-ray diffraction, metallography, and microhardness measurements were used to study phase equilibria in the ternary systems Ta–Fe–B and Ta–Ni–B. In the Ta–Fe–B system, the binary compound Ta_3B_2 was found to dissolve up to 20 at. % Fe, and its lattice constants were thereby reduced to a = 5.864, c = 3.274 A, and c/a = 0.557^+. The existence of three ternary compounds was detected. Phase analysis revealed no significant differences between Ta–Fe–B alloy specimens annealed at 1650 and 1450°C and those quenched from 950°C. No significant fields of solid solutions based on any of the binary compounds were discovered in the system Ta–Ni–B. However, the existence of three ternary compounds was established. The phase equilibria in the system Ta–Ni–B was found to be analogous to those in the system Nb–Ni–B. (P.C.H.)

7239 METALLOVEDENIE. STRUKTURA I SVOISTVA STALEI I SPLAVOV METALLIDY NOVYE METODY ISSLEDOVANIYA. (Metallography. Structure and Properties of Alloys and Metalloids. New Methods of Investigation). Reports of Symposium on Metallurgy and Metallography, Moscow, May 14–18, 1968. Ageev, N. V. (ed.). Moscow; Izdatel'stvo Nauka (1971). 544p. (CONF-680564).

Eighty-two papers are included; separate abstracts were prepared for 12. The remaining 70 papers contain information on thermochemical and thermomechanical hardening of steels, brittleness and aging of special iron alloys, chemical bonding in metallides, paramagnetic resonance of alloys, the chalcogenides of the transition metals, and aspects of the Moessbauer effect. (K.S.W.)

For abstracts of individual papers see: 7181, 7201–7203, 7225, 7240–7245, and 7670.

7240 WELL-REGULATED STRUCTURES OF CARBIDES AND NITRIDES OF TRANSITION METALS. Novotnyi, G.; Benezovskii, F. pp 315-23 of Metallovedenie. Struktura i Svoistva Stalei i Splavov Metallidy Novye Metody Issledovaniya. /Ageev, N. V. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Symposium on metallurgy and metallography; Moscow, USSR (14 May 1968).

It was established by means of electron and neutron diffraction that a well-regulated arrangement of atoms exists in the crystalline structures of the carbides and nitrides of the transition metals, such as V_2C, Nb_2C, and W_2C. For crystalline structures of transition metal compounds with nonmetals the difference depends on the structure and linking of the octahedral groups Me_6X, where Me is the transition metal atom and X is either N or C. In such well-ordered structures the shortest interatom distance Me–C–Me is shorter than the Me-hole-Me distance, and results from a shift of the metal atom from its normal position. Strong interaction of these atoms gives a high degree of stability to the subcarbides and subnitrides of the transition metals. (tr-auth)

7241 REACTION BETWEEN A STOICHIOMETRIC THORIUM CARBIDE AND HYDROGEN. Makovets, M.; Ban, Z. pp 324-6 of Metallovedenie. Struktura i Svoistva Stalei i Splavov Metallidy Novye Metody Issledovaniya. /Ageev, N. V. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Symposium on metallurgy and metallography; Moscow, USSR (14 May 1968).

The reaction of H_2 with samples of Th_2C ($Th-ThC_{0.7}$) was investigated using tensometry, x-ray analysis, NMR, and neutron diffraction. Absorption took place rapidly at 100°C, forming a cubic phase which corresponded to an elongated ThC-cell and possessed the composition $Th_2CH_{3.3}$. The cubic phase lost H at 380 to 400°C, and was irreversibly converted to the hexagonal modification. The lattice parameters of these two phases were a = 5.355 Å, and a = 3.816, c = 6.302 Å. Thermal analysis also confirmed the phase conversion. The presence of ThH_2 was detected by x-ray powder analysis at all stages of the process. NMR showed that the distance between protons in the hexagonal modification was 2.31 Å. (tr-auth)

7242 CHARACTER OF THE CHEMICAL BOND IN OXIDES AND CARBIDES OF METALS OF THE IVa AND Va SUBGROUPS. Gel'd, P. V.; Tskhai, V. A. pp 327-33 of Metallovedenie. Struktura i Svoistva Stalei i Splavov Metallidy Novye Metody Issledovaniya. /Ageev, N. V. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Symposium on metallurgy and metallography; Moscow, USSR (14 May 1968).

The uniqueness of the chemical bonds in oxides and carbides of the IVa and Va subgroups leads to a shielding of the Me–Me bond, which in turn is responsible for many of their structural and thermodynamic features. Such features include an increase in defects in the order FeO → VO_2, TiO → NbO, and the connection with an integral overlapping of the d_ε-orbit and the number of electrons in the Me–Me bond; the irregular character of the character of change in heat of atomization in the series MeC → MeN → MeO; a decrease in the number of intermediate oxides in the order (V–O) → (Ti–O) → (Nb–O), and their absence in the systems (Zr–O), (Hf–O), and (Ta–O). In statistical calculations of vacancy distribution it is essential to allow for the effect of screening the Me–Me bond. This also explains the character of vacancy ordering in $VC_{0.875}$, $NbC_{0.75}$, and $TaC_{0.75}$. (tr-auth)

7243 ELECTRONIC STRUCTURE OF MONOCARBIDES AND MONONITRIDES OF TRANSITION METALS. Neshpor, V. S. pp 333-41 of Metallovedenie. Struktura i Svoistva Stalei i Splavov Metallidy Novye Metody Issledovaniya. /Ageev, N. V. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Symposium on metallurgy and metallography; Moscow, USSR (14 May 1968).

Some properties of cubic carbides MeC_{1-x} were studied; changes in such properties with changes in the C content showed that the compounds $Me^{IV}C_{1-x}$ and $Me^{V}C_{1-x}$ are characterized by high coupling of associated electrons and relatively small area of free Fermi surface for nearly stoichiometric compositions. The free Fermi surface is expanded with a small C concentration, which is caused by an increase in the contribution of direct Me–Me interaction; the electrons responsible for this interaction fill a broadened energy band. The interatomic distances were compared with the metal atom radii for the carbides $TiC_{0.98}$, $ZrC_{0.97}$, and $HfC_{0.93}$. The properties and electron configuration of carbides of Nb, Ta, and V are discussed. (K.S.W.)

7244 OXYCARBIDES, CARBONITRIDES, OXYNITRIDES OF METALS OF THE IV–Va SUBGROUPS. Gel'd, P. V.; Shveikin, G. P.; Alyamovskii, S. I.; Shchetnikov, E. N.; Dubrovskaya, L. B. pp 373-81 of Metallovedenie. Struktura i Svoistva Stalei i Splavov Metallidy Novye Metody Issledovaniya. /Ageev, N. V. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Symposium on metallurgy and metallography; Moscow, USSR (14 May 1968).

Cubic and hexagonal structures from the systems Me–C–O, Me–C–N, and Me–N–O were studied where Me = Ti, Zr, Hf, V, Nb, and Ta. As a basis for formulating continuous series of solid solutions, the conditions of mutual solubility were adequately met. The atomic radii did not always play a determining role in the lattice periods of some of the cubic phases. The complexity of the elemental cells of separate phases is discussed. Vacancies in the sublattices of solid solutions occurred sufficiently often that the conservation of uniform average outer electron densities could be explained in the regions of homogeneity of these phases. (tr-auth)

7245 SOLID SOLUTIONS ZIRCONIUM–OXYGEN AND TITANIUM–OXYGEN. Dubertret, A.; Lehr, P. pp 381-8 of Metallovedenie. Struktura i Svoistva Stalei i Splavov Metallidy Novye Metody Issledovaniya. /Ageev, N. V. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Symposium on metallurgy and metallography; Moscow, USSR (14 May 1968).

The systems Ti−O and Zr−O were studied by hardness measurements and x-ray analyses of annealed samples. The solid solutions formed were far from ideal as a result of a considerable affinity of Ti and Zr for O, which resulted in the structures Ti_6O, Ti_3O, Zr_6O, and Zr_3O. Analogies in these systems are discussed, with the conclusion that analogy in the compositions does not result in a matching order of distribution of O atoms in the hexagonal, densely packed Ti and Zr structure. Introducing O into the octahedral space of a hexagonal densely packed structure caused deformation of this lattice. Different types of deformation of the Ti and Zr lattices suggest that in the solid solutions the Zr−O bond is more ionic than the Ti−O bond. Ordering was associated with decreased hardness of the alloy; deviation in hardness values of solid solutions of TiO and ZrO indicated the existence of many types of superstructures such as Ti_6O, Ti_3O, Ti_2O, Zr_6O, and Zr_3O. (tr-auth)

7246 INVESTIGATIONS ON THE SYSTEM BORON–CARBON. Kieffer, R. (Technische Hochschule, Vienna); Gugel, E.; Leimer, G.; Ettmayer, P. Ber. Deut. Keram. Ges.; 48: No. 9, 385-9(Sep 1971). (In German).

As regards the phases present the results of Elliot (ARF-2200-12, 1961) were confirmed: the only binary phase was boron carbide with a relatively large homogeneous area. With increasing replacement of C atoms by B there occurred a widening of the lattice detectable by x-ray. The liquidus temperature curve in this system between 0 and 16 atomic-% of carbon was considerably higher than was assumed until now. The eutectic between B_4C and C was at 26 atomic-% C and 2400°C. (auth)

7247 X-RAY DIFFRACTION ANALYSIS OF THE ϵ PHASE IN DILUTE Nb−C ALLOYS. Crane, Robert L.; Ostermann, F. (Air Force Materials Lab., Wright-Patterson AFB, Ohio). Met. Trans.; 2: No. 12, 3487-8(Dec 1971).

A proposal is given for a Bravais lattice and unit cell dimensions which satisfy the x-ray diffraction pattern of a nearly single-phase sample of the ϵ-carbide in dilute C−Nb alloys. (P.C.H.)

7248 ELECTRON DIFFRACTION STUDY OF SAMARIUM MONOXIDE. Kumar, Jitendar; Srivastava, O. N. (Banaras Hindu Univ., India). Jap. J. Appl. Phys.; 11: No. 1, 118-19 (Jan 1972).

When Sm metal powder was heated at 700°C for 5 hr, a partially oxidized mixture of Sm_2O_3−Sm resulted. The mixture was heated in vacuum, and the vapor was condensed on a glass slide. The condensed film was examined in an electron microscope and found to show the zinc blende-type fcc structure with $a = 5.15 \pm 0.05$ Å. Chemical microanalysis and oxidation weight gain confirmed that this substance was SmO. When it is heated by the electron beam and the resulting single-crystal regions pulse-annealed, a new substructure with a super lattice resulted from the oxygen loss. (D.L.C.)

Radiation Effects

Refer also to abstracts 8486, 8561, and 8608.

7249 (BNWL-1540) HIGH-TEMPERATURE IRRADIATIONS (1000 TO 1300°C) ON A VARIETY OF GRAPHITES TO EXPOSURES $>10^{22}$ n/cm². Pitner, A. L. (Battelle Pacific Northwest Labs., Richland, Wash.). July 1971. Contract AT(45-1)-1830. 113p. Dep. NTIS.

Twenty-one grades of graphite were irradiated in instrumented capsules at temperatures of 1000 to 1300°C to exposures approaching 15×10^{21} n/cm (E > 0.18 MeV). At 1000 to 1200°C, dimensional distortions were similar to those observed in lower-temperature irradiations but occurred at an accelerated rate. Above 1200°C, however, the expansion rate after turnaround in the transverse orientation was considerably reduced from that seen at 1000 to 1200°C, thereby increasing the useful lifetime of the graphite. Near-isotopic graphites displayed improved dimensional behavior over conventional graphites in that distortions were more isotropic and generally less severe, and turnaround was slower. Isotropic graphites with a high coefficient of thermal expansion ($\sim 7 \times 10^{-6}$ in./in./°C) showed rapid expansion at the onset of irradiation, but after about 2×10^{21} n/cm², the expansion rate decreased to nearly zero for the high-density materials and actually became negative for the low density graphites. Expansion again became prevalent after about 10^{22} n/cm², but the expansion rates were less than observed in conventional graphites at high fluences. Above 1200°C, the isotropic graphites contracted under irradiation. Dimensional changes in these materials were generally quite small (<1%). In the conventional, anisotropic graphites the coefficient of thermal expansion (CTE) generally decreased about 25% with irradiation, but then increased after an exposure corresponding to dimensional turnaround. The high CTE isotropic graphites showed a reduction from approximately 7×10^{-6} in./in./°C to ½ in./in./°C with irradiation. Electrical resistivity increased by a factor of approximately 2½ when the irradiation temperature was below 1200°C but only doubled at temperatures of 1200 to 1300°C. Young's modulus generally increased with irradiation exposure, with a smaller increase at 1200 to 1300°C than at 1000 to 1200°C. (auth)

7250 (GULF-GA-A-10507) IRRADIATION-INDUCED MICROSTRUCTURAL CHANGES IN A TWO-PHASE BINDER-FILLER GRAPHITE. Engle, G. B. (Gulf General Atomic, Co., San Diego, Calif.). 17 Sep 1971. Contract AT(04-3)-167. 14p. (CONF-711030-1). Dep. NTIS.

From twenty-fourth Pacific Coast regional meeting of the American Ceramic Society; Anaheim, Calif. (30 Oct 1971).

A binder-filler graphite with two distinct carbon structures, needle coke and pyrolytic carbon, was irradiated at 1300°C to 4×10^{21} n/cm² (E > 0.1 MeV). The volume change of the composite binder-filler was determined by density and dimensional measurements, and the volume change of each carbon structure and the gross porosity were followed by lineal analysis. The volume change of each carbon structure was also determined external to the composite by density measurements. The bulk compact densified by the elimination of pores between the carbon and graphite filler particles and by elimination of pores and density defects within the needle-coke and pyrolytic carbon filler particles. Concurrently, during bulk densification of the composite, microcracks began to form immediately within the needle-coke particles. (auth)

7251 INFLUENCE OF RADIATION ON THE STRUCTURE OF ALUMINUM HYDROXIDE. Koryukov, V. N.; Kuznetsov, S. I.; Derevyankin, V. A.; Shklyar, R. Sh. (Ural Polytechnic Inst., Sverdlovsk, USSR). J. Appl. Chem. USSR (Engl. Transl.); 44: No. 4, 910-12(Apr 1971).

Translated from Zh. Prikl. Khim.; 44: No. 4, 909-11(Apr 1971).

Studies were made on changes in certain properties of aluminum hydroxides under the influence of radiation in order to elucidate the mechanism of the effects of γ radiation on their dissolution and crystallization. The results showed that γ irradiation changed the color of gibbsite from yellow to pale pink to bluish-gray depending on the dose. Interference lines in the electron diffraction pattern of irradiated gibbsite corresponded more closely to boehmite than to gibbsite. It was concluded that photoelectrons produced by the action of γ radiation on aluminum hydroxides are localized at defects on the crystal surface or at cations. This not only leads to changes in the charges of particles present at the lattice sites but may even be ultimately accompanied by partial dehydration of the original hydroxide. This is quite possible if local overheating of the specimens is presumed. (P.C.H.)

7252 IRRADIATION ENHANCED DECOMPOSITION OF A NICKEL–CARBON SOLID SOLUTION. Shriver, B. L.; Wuttig, M. (Univ. of Missouri, Rolla). Acta Met.; 20: No. 1, 1-4(Jan 1972).

Studies were made on the effects of room temperature neutron irradiation on the distribution of carbon in a nickel−0.3 wt % carbon alloy. The experiment consisted of comparing the amount of carbon in solid solution and the internal stresses of both unirradiated and irradiated (10^{13} fast neutrons-cm^{-2} $< \Phi_F < 10^{18}$ f-cm^{-2}) samples following isochronal anneals between 100 and 1200°C by using the magnetic disaccommodation technique. The results indicated that the amount of carbon remaining in solid solution decreases with increasing neutron dose. At temperatures below 200°C this was due to the trapping of carbon by mobile irradiation-produced defects. Between 200 and 600°C the formation of metastable carbides was enhanced by the presence of irradiation-produced defects. No differences were observed in irradiated and unirradiated samples above 600°C. (auth)

7253 IRRADIATION STUDIES IN RAPSODIE OF MIXED CARBIDE FUEL PINS. Ratier, J. L. (CEN, Cadarache, France). Atomwirt., Atomtech.; 136-7(Mar 1971). (In German).

Two experiments designed for study of various mixed carbide fuel pins are described. The mixed carbide fuels were composed of UPuC, UPuN, UPuCN, or UPu, CMo, and UPuCZr. Two lattice arrangements—Camille and Millesimo—are to be used. The pins are clad in Type 316 stainless steel. The stresses on the cladding are discussed. (J.S.R.)

Plastics and Other Materials

Refer also to abstracts 6611 and 7733.

7254 PROCESS FOR COATING SUBSTRATES WITH POLYMERIZABLE BETA-HYDROXY ESTERS. (to Continental Can Co., Inc.). British Patent 1,241,851. 4 Aug 1971. Priority date 27 Jan 1969, United States.

A process is described for application of coatings on articles comprising an ethylenically unsaturated ester having a hydroxyl group beta in the ester linkage which is prepared by the reaction of a polyepoxide having at least 2 epoxide groups with an alpha, beta-unsaturated monocarboxylic acid containing 3 to 7 C atoms. The film is exposed to a source of ionizing radiation for a time sufficient to effect polymerization of the ester. (J.R.D.)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Stars

Refer also to abstract 8053.

7255 SUPERNOVAE DISCOVERED SINCE 1885. Kowal, Charles T.; Sargent, Wallace L. W. (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.). Astron. J.; 76: No. 9, 756-64(Nov 1971).

All confirmed supernovae discovered between 1885 and May 1971 are listed in two tables. (auth)

7256 NOVAE IN THE MAGELLANIC CLOUDS DURING THE 1970–1971 OBSERVING SEASON. Graham, J. A.; Araya, G. (Cerro Tololo Inter-American Observatory, La Serena, Chile). Astron. J.; 76: No. 9, 768-74(Nov 1971).

A new survey for Magellanic Cloud novae was initiated at Cerro Tololo Inter-American Observatory. During the period September 7, 1970 to March 30, 1971, two novae were discovered in the Large Magellanic Cloud. The methods used for the survey are discussed. Two photographs identifying the two novae in the surrounding star fields are published. Some photometric observations of the decline of the two novae are also presented. (auth)

7257 PHOTOMETRY OF MAIN-SEQUENCE STARS IN THE HYADES AND THE FIELD ON THE BVr SYSTEM. Mannery, Edward J.; Wallerstein, George (Univ. of Washington, Seattle). Astron. J.; 76: No. 9, 890-5(Nov 1971).

Observations of stars in the Hyades and stars earlier than type M0 with trigonometric parallaxes greater than 0.080 were made on the BVr system. The color index V − r is shown to correlate well with MK spectral type and effective temperature. Color−magnitude diagrams were drawn using M_v and V − r for the field stars and V and V − r for the Hyades stars. By comparing color−magnitude diagrams a distance modulus for the Hyades of 3.24 mag was found in agreement with the modulus derived from dynamical parallaxes. (auth)

7258 INCIDENCE OF METALLICISM AMONG MID A-TYPE STARS. Smith, Myron A. (Kitt Peak National Observatory, Tucson, Ariz. Lick Observatory, Santa Cruz, Calif.). Astron. J.; 76: No. 9, 896-900(Nov 1971).

Quantitative measures of the Ca II K-line strength and of a Sc II/Sr II line ratio were taken from a random sample of 70 bright mid-to-late A stars to determine the incidence of Am stars for this spectral region. It was found that some 31% were Am, 10% were Ap, and at most only 59% were "normal." This incidence for metallicism peaks in the center of the Am spectral domain, at A6−A7. Use of these spectral indices alone becomes about as reliable as classification of these stars at intermediate spectral dispersions, however in a few borderline cases, supplemental line ratios are useful. The merging of the indices between the Am and normal A groups implies that a transitional rather than a discrete boundary exists between them. (auth)

7259 POLARIMETRY OF RED AND INFRARED STARS AT 1 TO 4 MICRONS. Dyck, H. M. (Kitt Peak National Observatory, Tucson, Ariz.); Forbes, F. F.; Shawl, S. J. Astron. J.; 76: No. 9, 901-15(Nov 1971).

Polarimetric data in the 1- to 4-μ spectral range are presented and discussed for 64 stars, mostly of late spectral type. It is shown that large polarization in the near-infrared is usually associated with extreme circumstellar shell characteristics among the cool stars. Variable polarization in the near-infrared has not yet been found that exceeds 1%, if it exists at all. Many previously unidentified infrared sources from the Caltech 2-μ survey were found to be intrinsically polarized. Particular attention was paid to VY CMa, previously shown to be peculiar polarimetrically by Forbes. A qualitative model was developed in which the circumstellar shell contains two discrete particle sizes, one of the order of 1 μ (radius) and the other of the order of 0.1 μ. For a hypothetical optically thin analog, it is demonstrated that all of the polarimetric features observed in VY CMa can be reproduced in an asymmetric circumstellar envelope containing spherical grains of (Mg, Fe) SiO_3. (auth)

7260 PHOTOMETRY OF VARIABLES IN GLOBULAR CLUSTERS. III. M14 AND THE PERIOD–LUMINOSITY RELATION OF POPULATION II CEPHEIDS. Demers, Serge (Laurentian Univ., Sudbury, Ont. Cerro Tololo Inter-American Observatory, La Serena, Chile); Wehlau, Amelia. Astron. J.; 76: No. 9, 916-22(Nov 1971).

B and V photographic photometry of five Population II Cepheids in M14 is presented. The plates are calibrated with a new photoelectric sequence. The mean magnitudes and colors of the M14 variables are combined with Population II Cepheids in ω Cen, M2, and M13. These 17 variables define a period−luminosity relation given as $\langle M_V \rangle = -0.16 - 1.65 \log P$. No period−color relation is evident for all stars but the M14 and ω Cen variables do follow a P−C relation with almost identical slope. (auth)

7261 LIGHT VARIATIONS OF XY BOOTIS AND LS HERCULIS. Binnendijk, L. (Univ. of Pennsylvania, Philadelphia. Kitt Peak National Observatory, Tucson, Ariz.). Astron. J.; 76: No. 9, 923-9(Nov 1971).

A total of 441 observations in yellow light and 440 observations in blue light are presented for the system XY Bootis. The period is variable and the light curve of this W UMa-type system shows partial eclipses which, after rectification, become very shallow. LS Herculis was observed during six consecutive nights. The period and the shape of the light curve change during this relative short time interval. Reasons are given to indicate that LS Her is probably an RR Lyrae-type variable. (auth)

7262 PERTURBATION OF G24-16. Harrington, Robert S. (Naval Observatory, Washington, D. C.). Astron. J.; 76: No. 9, 930-1(Nov. 1971).

The star G24-16 has a Keplerian perturbation with a semimajor axis of 0.029″ and a period of 1.5 yr from its proper and parallactic motions. The unseen companion is probably an underluminous dwarf with a mass in the range 0.07 to 0.11 $M_\odot$. (auth)

7263 EXCITATION MECHANISM OF N III EMISSION IN THE Of STARS. Brucato, Robert J. (Northwestern Univ., Evanston, Ill.); Mihalas, Dimitri. Mon. Notic. Roy. Astron. Soc.; 154: No. 4, 491-503(1971).

A simplified statistical equilibrium calculation was carried out to examine the mechanism of the N III $\lambda\lambda$ 4634-41 emission in Of stars. It is shown that the Swings mechanism, based on pumping in the ultraviolet $\lambda\lambda$ 374 and 452 transitions is probably correct, while the Bowen mechanism, applicable in nebulae, is almost certainly not operative in the Of stars. The possible importance of dielectronic recombinations to the 3d state is pointed out. (auth)

7264 LITHIUM-RICH STAR IN Sco–Cen. Catchpole, R. M. (Radciffe Observatory, Pretoria). Mon. Notic. Roy. Astron. Soc.; 154: No. 4, 15P-17P(1971).

The Sco−Cen star HD 113703 ft (KoVe) is shown to have a high lithium abundance ($\log N_{Li} \simeq +2.8$). (auth)

7265 CELLULAR CONVECTION IN MODEL STELLAR ENVELOPES. Mullan, D. J. (Armagh Observatory, Ireland). Mon. Notic. Roy. Astron. Soc.; 154: No. 4, 467-89(1971).

Model stellar envelopes were constructed using a theory of cellular convection due to Öpik, in which turbulent heat exchange between rising and falling gas is allowed for by introducing an experimentally determined coefficient. Radiative heat losses are also included. A model of the solar convection zone is found to be only 1.04×10^4 km deep, with a bottom temperature of 9.84×10^4°K, and a gas pressure $\log P_g = 7.69$. Supergranules are considered to be convection cells penetrating the entire convection zone. Temperature inhomogeneities in the upper convection zone exhibit a plateau in the region $0.5 \lesssim \tau \lesssim 1.3$. In models of main-sequence stars, the maximum convective velocity is found to have a peak value (10.9 km s^{-1}) at spectral type A6, with a rapid drop at earlier spectral types. Supergranule cells increase in size abruptly by a factor of almost 2 between spectral types G0 and G2. Metal-poor stars have lower convective velocities than metal-rich stars in the deeper layers. (auth)

7266 MEASUREMENT OF LIMB DARKENING ON WHITE DWARF BD + 16^0 516B. Warner, Brian; Robinson, Edward L.; Nather, R. Edward. Mon. Notic. Roy. Astron. Soc.; 154: No. 4, 455-65(1971).

BD + 16 516° is an eclipsing binary with 0.52 day period consisting of a Ko V star and a white dwarf. Primary eclipse in the U band was observed with half second time resolution. A least-squares fit of theoretical eclipse curves, including limb darkening of the white dwarf and limb curvature of the Ko V, to two ingresses and one egress leads to an estimate of u = 0.366 ± 0.037 for the limb-darkening coefficient. This is in excellent agreement with that for a grey atmosphere. (auth)

7267 VARIABLE STARS IN A FIELD CENTERED AT $l^{II} = 0^0$, $b^{II} = -10^0$ (FIELD 3 OF THE PALOMAR–GRONINGEN VARIABLE-STAR SURVEY). Plaut, L. (Kapteyn Astronomical Lab., Groningen, Netherlands). Astron. Astrophys., Suppl. Ser.; 4: No. 2, 75-230(Sep 1971).

A description is given of the observations of faint variable stars in field 3 of the Palomar–Groningen variable-star survey and of the reduction methods used. A series of tables and figures shows the detailed data as obtained for various kinds of variables. (auth)

7268 DYNAMICS AND THERMAL STABILITY OF PLANETARY NEBULAE. Hunter, James H.; Sofia, Sabatino (Univ. of Southern Florida, Tampa). Mon. Notic. Roy. Astron. Soc.; 154: No. 41, 393-413(1971).

Dynamical models of planetary nebulae are constructed utilizing a semi-analytical approach. The influence of the various physical parameters upon the thermal histories of the expanding nebular shells is investigated. Also, the thermal stability of the nebulae is rediscussed from a fundamentally new viewpoint. It is demonstrated that thermal instability may occur early in the lifetime of a nebula provided that it evolves through a high temperature phase, presumably resulting from mechanical heating associated with the ejection process. (auth)

7269 NATURE OF ETA CARINAE. Davidson, Kris (Princeton Univ. Observatory, N. J.). Mon. Notic. Roy. Astron. Soc.; 154: No. 4, 415-27(1971).

Various details of the spectrum of η Carinae are found to be consistent with a model in which a compact H II region is photoionized by radiation from a very massive star whose surface temperature is about 30,000°K. The infrared spectrum is presumed to be thermal re-emission from dust surrounding the ionized region. (auth)

7270 OBSERVATIONS OF INTENSITY MODULATION OF STARLIGHT AT DISCRETE RADIO FREQUENCIES. Morris, Glen J. (EG and G, Inc., Albuquerque, N. Mex.). Phys. Rev. Lett.; 27: No. 23, 1600-4(6 Dec 1971).

Components modulated in intensity at discrete radio frequencies have been detected in the light from several stars. The effect is believed to be due to time-dependent, very-small-angle scattering of the starlight by enhanced electron density fluctuations in the ionosphere. (auth)

7271 THERMONUCLEAR ORIGIN OF RARE NEUTRON-RICH ISOTOPES. Howard, W. Michael; Arnett, W. David; Clayton, Donald D.; Woosley, Stanford E. (Rice Univ., Houston, Tex. Inst. of Theoretical Astronomy, Cambridge, Eng.). Phys. Rev. Lett.; 27: No. 23, 1607-10(6 Dec 1971).

Many rare neutron-rich isotopes in the range $16 \leq Z \lesssim 34$ can be synthesized from seed nuclei exposed to explosive carbon burning. This process, which involves no new astrophysical parameters, can solve most of the outstanding problems in the thermonuclear synthesis of elements in the range $Z \lesssim 34$. (auth)

7272 CONTRIBUTION OF COSMIC RAY NUCLEI TO METALLIC ELEMENTS IN POPULATION II STARS. Hayakawa, Satio (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 46: No. 3, 994-5(Sep 1971).

The possibility is pointed out that cosmic rays generated in other galaxies transport heavy nuclei to a newly formed galaxy and contribute to the abundance of metallic elements in Population II stars. (W.D.M.)

7273 GALACTIC X RAYS FROM UNRESOLVED FLARE STARS. Edwards, P. J. (Univ. of Otago, Dunedin, New Zealand). Nature (London) Phys. Sci.; 234: No. 47, 75-6(22 Nov 1971).

The existence of a class of unresolved low intrinsic luminosity x-ray sources has been suggested to account for observations of a galactic disk component of diffuse x radiation. The present author shows that x-ray bursts from red-dwarf flare stars may generate a time-averaged disk intensity above 1.5 keV, that satisfies the observational requirements; also that current estimates of the luminosity of individual flare x-ray bursts imply a disk intensity substantially greater than that observed. Studies of other workers in relevant fields are also briefly summarised. Among conclusions reached is that the hard x-ray luminosity of flare stars has been substantially over-estimated, and that the energy radiated in soft x rays is <1% of the optical flare energy. (UK)

7274 DUST IN THE CRAB NEBULA. Aitken, D. K.; Polden, P. G. (University Coll., London). Nature (London) Phys. Sci.; 234: No. 47, 72-3(22 Nov 1971).

Observations of the Crab at 10 μm indicate a flux of 170 ± 50 f.u. compared with 30 f.u. to be expected from the usual synchrotron model, and the implications of this excess are discussed. The difficulty of excessive fields over a large volume can be avoided if the radiation is produced in a number of small regions scattered throughout the nebula. If, in addition to the continual injection of electrons into the nebula, a sudden burst occurred at the time of the supernova event, then a bump may occur in the synchrotron spectrum. The authors computed the synchrotron spectrum for a number of different burst injection spectra. It was found that only a nearly monochromatic burst component with energy $\sim 10^{11}$ eV could account for the 10-μm excess, without elevating the mm flux above the extrapolated radio spectrum. Assuming a normal mm flux, the possibility is considered that the 10-μm excess is the result of thermal omission from dust grains. The mass of dust in the Crab is calculated for the case of graphite. Silicates may also contribute significantly at higher wavelengths (~100 μm). (UK)

7275 RADIO OBSERVATIONS OF MAGNETIC WHITE DWARFS. Hughes, V. A.; Feldman, P. A.; Woodsworth, A. (Queen's Univ., Kingston, Ont.). Astrophys. J.; 170: No. 3, L125-6(15 Dec 1971).

Radio observations at 10.63 GHz (2.8 cm) were made of a number of magnetic white dwarfs. Upper limits of a few times 10^{-2} flux units were obtained. (auth)

7276 LONG WAVE TRAINS OF GRAVITATIONAL WAVES FROM A VIBRATING BLACK HOLE. Press, William H. (California Inst. of Tech., Pasadena). Astrophys. J.; 170: No. 3, L105-8(15 Dec 1971).

The vibrations of a black hole of mass M, perturbed from spherical symmetry, were studied numerically. Initial perturbations of high spherical-harmonic index ($l \gg 1$) which contain Fourier components of long wavelength ($2\pi M \gtrsim \lambda \gg 2\pi M/l$) produce long-lasting vibrations. The vibrational energy is radiated away gradually as a long, nearly sinusoidal wave train of gravitational radiation with angular frequency $\omega \approx (27)^{-1/2}\, 1/M$. (auth)

7277 HCN IN IRC + 10216. Morris, M. (Univ. of Chicago); Zuckerman, B.; Palmer, Patrick; Turner, B. E. Astrophys. J.; 170: No. 3, L109-12(15 Dec 1971).

$H^{12}C^{14}N$ and $H^{13}C^{14}N$ were observed and $H^{12}C^{15}N$ was searched for in the infrared object IRC + 10216. The $[^{13}C][^{14}N]/[^{12}C][^{15}N]$ ratio is different from the terrestrial one. If it is assumed that the HCN lines originate in the same region as CO lines from this source, then the $^{12}C/^{13}C$ abundance ratio is ~15. (auth)

7278 ULTRASHORT-PERIOD BINARIES, GRAVITATIONAL RADIATION, AND MASS TRANSFER. I. THE STANDARD MODEL, WITH APPLICATIONS TO WZ SAGITTAE AND Z CAMELOPARDALIS. Faulkner, John (Univ. of California, Santa Cruz). Astrophys. J.; 170: No. 3, L99-104(15 Dec 1971).

Gravitational-radiation losses, by reducing the scale size of the system, induce mass transfer in the U Geminorum cataclysmic variables at the observed rate. The systems evolve from those having periods ~10h to the shortest period observed, ~1h21.6m, in times typically of a few billion years or less. (auth)

7279 GUM NEBULA. Maran, Stephen P. Sci. Amer.; 225: No. 6, 20-9(Dec 1971).

The discovery, detailed studies, and possible origins of the Gum Nebula are reviewed. (W.D.M.)

7280 RED-GIANT EVOLUTION TO THE HELIUM FLASH OF A SUPER-METAL-RICH STAR. Demarque, Pierre; Heasley, James N. (Yale Univ., New Haven). Mon. Notic. Roy. Astron. Soc.; 155: No. 1, 85-94(1971).

An evolutionary sequence is presented for a star of 1.19 $M_\odot$, with composition parameters (X, Z) = (0.69, 0.06). The evolution was followed from the main sequence to the onset of convection in the core during the helium flash. The resulting core mass at the helium flash, $M_c = 0.446\ M_\odot$ is smaller than those found for Population II stars with the same helium abundance. No mixing between hydrogen-rich envelope and the helium core can be expected due to the noncentral development of the flash. The clumping of stars on the giant branch of old open clusters, discussed by Cannon (Mon. Not. Roy. Astron. Soc., 150: 111(1970)), is considered. (auth) (UK)

7281 TEMPERATURES, ABUNDANCES, AND GRAVITIES OF F DWARF STARS. Bell, R. A. (Univ. of Maryland, College Park). Mon. Notic. Roy. Astron. Soc.; 155: No. 1, 65-83(1971).

Theoretical colors, computed using laboratory line data and model stellar atmospheres, were used to interpret the colors of about 150 F and early G dwarfs. Effective temperatures were derived from the Hβ index and from R – I, abundances were obtained from m_1 and b – y, and gravities were obtained from c_1 and b – y. The effective temperatures and gravities were in good agreement with values obtained from spectral scans. Much less observing time was required to obtain the colors than to obtain scans and the reduction procedure was also far simpler. Absolute magnitudes were obtained from the effective temperatures and the gravities, the latter being used with assumed stellar masses to yield radii. The root mean square difference between photometric absolute magnitudes and trigonometric ones was about 0.4 magnitudes. The present results provide theoretical justification for the empirical formulae given by Crawford (1966) and by Strömgren (1966) for the determination of absolute magnitudes and abundances from uvby photometry. (auth) (UK)

7282 PHOTOELECTRIC RADIAL VELOCITIES. PAPER IV. 528 7^m TO 10^m STARS IN THE +15° SELECTED AREAS. Griffin, R. F. (Observatories, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 155: No. 1, 1-49(1971).

A total of nearly 1500 radial-velocity observations of more than 500 7 to 10m stars was made with a photoelectric spectrometer. Nearly every star was observed in more than one season. The standard errors of individual observations were mostly in the range 1.0 to 1.5 km/s. Eighty-five per cent of the mean velocities had standard errors of 1.0 km/s or better. The number of stars for which such good velocities are available is thereby increased by a third; almost all the good velocities known hitherto refer to naked-eye stars. A comparison of the photoelectric results with the 41 b-quality velocities available for the same stars in the Radial Velocity Catalogue shows the standard error of the catalogue velocities to be 3.2 ± 0.4 km/s. (auth) (UK)

7283 GRAVITATIONAL RADIATION FORM A PARTICLE FALLING RADIALLY INTO A SCHWARZSCHILD BLACK HOLE. Davis, Marc (Princeton Univ., N. J.); Ruffini, Remo; Press, William H.; Price, Richard H. Phys. Rev. Lett.; 27: No. 21, 1466-9(22 Nov 1971).

The spectrum and energy of gravitational radiation from a "point test particle" of mass m falling radially into a Schwarzschild back hole of mass M ≫ m were computed. The total energy radiated is about $0.0104mc^2(m/M)$, 4 to 6 times larger than previous estimates; the energy is distributed among multipoles according to the empirical law $E_{21\text{-pole}} \approx (0.44m^2c^2/M)e^{-21}$; and the total spectrum peaks at an angular frequency $\omega = 0.32c^3/GM$. (auth)

7284 SPECTRUM OF THE A 21 NEBULA. Chopinet, M.; Lortet Zuckermann, M. C. (Univ., Bordeaux. CNRS, Saint-Michel, France. CNRS, Paris). Compt. Rend., Ser. B; 273: No. 12, 513-16(20 Sep 1971). (In French).

The A21 nebula, classified as special by certain workers, was recently observed using an image tube. The spectrum obtained does not confirm the anomalies which have been attributed to it. (France)

7285 INFRARED SPECTRUM OF IC 418. Kovar, R. P. (Manned Spacecraft Center, Houston, Tex.); Potter, A. E.; Kovar, N. S.; Trafton, L. Astrophys. J.; 170: No. 3, 449-52(15 Dec 1971).

Observations of the intensities of the Paschen lines in the spectrum of IC 418 together with published measurements of the Balmer-line intensities were utilized to derive a reddening constant, c = 0.31. The corrected flux value for Paschen β was log [I(Pβ)/I(Hβ)] = –0.76. Two additional emission lines, one at 9202 cm^{-1} (λ ~ 1.087 μ) and the second at 5890 cm^{-1} (λ ~ 1.698 μ), are briefly discussed. (auth)

7286 EVOLUTION OF GALAXIES. I. FORMULATION AND MATHEMATICAL BEHAVIOR OF THE ONE-ZONE MODEL. Talbot, Raymond J. Jr.; Arnett, W. David (Rice Univ., Houston, Tex.). Astrophys. J.; 170: No. 3, 409-22(15 Dec 1971).

A procedure is discussed for calculating the evolution of a closed system of gas and stars. Numerical and analytical solutions are given for a simple set of prescriptions for the stellar birth rate and the evolutionary end state of stars. The various features of the numerical results are easily understood through the analytic solutions. More significantly, the analytic solutions clearly display how the results will change when the astrophysical input is varied. A fundamental result, which previous investigators have not stressed, is that the metal content Z of the gas in a galaxy need not be a monotonically increasing function of time even if the system is homogeneous in space. It is shown that under conditions which lead to only a small fraction of mass in the form of gas, there generally may exist an early period with Z much larger than the present value. It is proposed that the very old super-metal-rich stars under investigation by Spinrad and others could have been formed during such a period. (auth)

7287 MODEL OF EPSILON AURIGAE. Wilson, Robert E. (Univ. of South Florida, Tampa). Astrophys. J.; 170: No. 3, 529-39(15 Dec 1971).

Previous models for ϵ Aur by Huang and by Cameron, which involve dynamically very improbable disks of orbiting material, are criticized on grounds that they cannot represent the observations (Cameron) or require the primary star to be larger than one can reasonably admit (Huang). A more conventional dust ring, with a semitransparent central opening, is found to represent the eclipse observations satisfactorily and to account for the general features of the secondary spectrum. There is good evidence that an eclipse of the primary by the secondary "star" was actually observed in 1956 and that the secondary's dimensions, for the purpose of producing this eclipse, were those of a giant star. If one considers the full implications of this "stellar" eclipse, however, the simplest explanation currently in view would be that the secondary is a collapsed object (black hole) surrounded in 1956 by a temporary dust cloud. It is also shown that ϵ Aur may be somewhat closer and less luminous than it has been regarded in most other theoretical studies. The unexpectedly high excitation temperature indicated by the additional spectral lines seen in eclipse may result from thin-source bremsstrahlung which originates from matter falling into the black hole. (auth)

7288 COMMENT ON THE INTERPRETATION OF THE BROAD COMPONENT OF N III λλ 4634 TO 4640 EMISSION IN Of STARS. Mihalas, Dimitri (Yerkes Observatory, Williams Bay, Wis.). Astrophys. J.; 170: No. 3, 541-5(15 Dec 1971).

The stabilizing transition from the N III autoionizing term $2s2p(^1P^0)3d\ ^2F$ to the bound double-excitation term $2s2p(^1P^0)3p\ ^2D$ gives rise to a very broadened doublet at the wavelengths 4623 and 4630 Å. A study of the rate at which the process occurs suggests that this stabilizing transition may appreciably contribute to the broad emission ("band") component near λλ4634 to 4640 as observed by Wilson and Underhill. It further appears that dielectronic recombination to the $2s^23d$ level from $2s2p(^1P^0)3d$ via the $2s2p \rightarrow 2s^2$ stabilizing transition occurs at a rate sufficiently large to outweigh direct radiative recombinations and at a substantial fraction of the decay rate of $2s^23d \rightarrow 2s^23p$; this process may therefore play an important role in producing the "line" component of the N III λλ4634 to 4640 emission. (auth)

7289 V605 AQUILAE: A NOVA-LIKE VARIABLE IN AN OLD PLANETARY NEBULA. Ford, Holland C. (Univ. of Oregon, Eugene). Astrophys. J.; 170: No. 3, 547-9(15 Dec 1971).

The outburst of V605 Aql is shown to have occurred near the center of the low-surface-brightness nebula Abell 58. Hα photographs show no perceptible expansion since 1951. A spectrum of the nebula shows Hα and [N II] λ6584 in emission, with [N II] λ6584 stronger than Hα. The new observations associate the outburst of V605 Aql with the central star of the old planetary nebula A58. (auth)

7290 TURBULENCE VELOCITIES IN THE ATMOSPHERE OF ALPHA ORIONIS. Hutchison, Robert B. (California Inst. of Tech., Pasadena). Astrophys. J.; 170: No. 3, 551-5(15 Dec 1971).

The curve of line-width correlation was applied to OH lines in the spectrum of α Ori, and the characteristic turbulence and thermal velocities in the atmosphere of this star were determined: $\xi_m = 9.9 \pm 2.0$ km s^{-1} (microturbulence); $\xi_M \lesssim 3$ km s^{-1} (macroturbulence); $\xi_{th} \simeq 1.8$ km s^{-1} (thermal). Implications of these results are discussed. (auth)

7291 THERMALIZATION LENGTHS AND MEAN NUMBERS OF SCATTERINGS FOR LINE PHOTONS. Athay, R. Grant; Skumanich, A. (National Center for Atmospheric Research, Boulder, Colo.). Astrophys. J.; 170: No. 3, 605-11(15 Dec 1971).

A simple algebraic method is given for the derivation of approximate thermalization lengths, mean number of scatterings for line photons, and scaling laws for the maximum value of the line-source function in finite atmospheres. The method utilizes only the shape of the line absorption coefficient. (auth)

7292 ABUNDANCE ANALYSIS OF COOL CARBON STARS. Utsumi, Kazuhiko (Tokyo Gakugei Univ.). Publ. Astron. Soc. Jap.; 22: No. 1, 93-112(1970).

Curve-of-growth analyses were made for 22 cool carbon stars, and excitation temperatures, turbulent velocities, damping constants, electron pressures were obtained. Relative abundances of the following elements were determined: Ca, Sc, Ti, V, Cr, Mn, Fe, Sr, Y, Zr, Ba, La, Ce, Pr, Nd, and Sm. In all the stars studied, Ca, Sc, Ti, V, Cr, and Mn show nearly normal abundances with respect to Fe. In RY Dra, UV Cam, Y CVn, and WZ Cas, Sr, Y, Zr, and Ba show nearly normal abundances, while rare-earth elements are overabundant by factors of 10 to 100. In other stars, heavier elements from Sr on are overabundant by factors of 10 to 100. This characteristic of overabundance is similar to that in Ba II stars, but is more extreme. (auth)

7293 ORBIT OF THE DOUBLE-LINE SPECTROSCOPIC BINARY HR4072 (Ap). Nariai, Kyoji (Tokyo Univ.). Publ. Astron. Soc. Jap.; 22: No. 1, 113-18(1970).

Velocities for both components of HR4072 (=HD89822) were measured on high-dispersion spectrograms. A new spectroscopic orbit was determined. The mass ratio was found to be 1.67 ± 0.04, which is very close to the value expected from the mass–luminosity relation, $\log L/L_\odot = 3.3 \log M/M_\odot$ (Guthrie, 1966). (auth)

7294 FLUORESCENT LINES OF SiH MOLECULE IN THE SPECTRA OF LONG-PERIOD VARIABLE STARS. Maehara, Hideo (Tokyo Univ.). Publ. Astron. Soc. Jap.; 22: No. 1, 119-23(1970).

Two emission lines at λλ 4138 and 4178 in the spectra of long-period variable stars were identified with the fluorescent lines of the SiH molecule excited by Hδ emission. (auth)

7295 NON-RADIAL OSCILLATIONS: LAGRANGE'S FORMALISM. Ishizuka, Tashihisa (Ibaraki Univ., Mito, Japan). Publ. Astron. Soc. Jap.; 22: No. 1, 125-7(1970).

The equations governing linear nonradial oscillations are formulated in Lagrange's form. (auth)

7296 TIME OF RELAXATION OF A GLOBULAR CLUSTER. Mendis, D. Asoka (Univ. of Ceylon, Colombo). Publ. Astron. Soc. Jap.; 22: No. 2, 137-42(1970).

The time of relaxation of a globular cluster is calculated on the basis of an initial non-Maxwellian velocity distribution compatible with a polytropic spatial distribution of index 5. The result is compared with earlier calculations, which assumed initial Maxwellian velocity distributions. (auth)

7297 GIANT, ASYMPTOTIC, AND HORIZONTAL BRANCHES OF THE GLOBULAR CLUSTER M5. Simoda, Mahiro (Tokyo Univ. Kitt Peak National Observatory, Tucson, Ariz.); Tanikawa, Kiyotaka. Publ. Astron. Soc. Jap.; 22: No. 2, 143-55(1970).

The color–magnitude diagram for brighter stars in M5 was obtained, using plates by the Kitt Peak 84-inch telescope and Arp (1962) standard stars. It was found that intrinsic widths for the giant, asymptotic, and yellow horizontal branches are very small (standard deviations were about ±0.02 mag and possibly less), and that the blue horizontal branch has a significant intrinsic width (the standard deviation was about ±0.1 mag). For all branches, the numbers of stars for r = 1 to 8′ are given, and lifetimes are derived, using also a preliminary countdown to the turnoff point and theoretical models by Simoda and Iben (1968, 1970). Lifetimes for the giant branch were roughly consistent with theoretical estimations. Luminosity functions for all branches are given in 0.1 mag intervals. The giant branch has a pronounced peak at $V \sim 15.0$ and two gaps on both sides of the peak. The asymptotic branch also has a nonsmooth luminosity function. (auth)

7298 NOTE ON THE APPROXIMATION OF H-FUNCTION FOR ISOTROPIC SCATTERING. Karanjai, Sitansubimal (Univ. of North Bengal, West Bengal, India); Sen, Manju. Publ. Astron. Soc. Jap.; 22: No. 2, 235-8(1970).

A new approximate form for Chandrasekhar's H-function for isotropic scattering is derived. This form is helpful in the calculation of contours of strong absorption lines. (auth)

7299 REMARK ON THE DETERMINATION OF ELECTRON PRESSURE FROM THE ANALYSIS OF STELLAR SPECTRA. Yamashita, Yasumasa (Tokyo Univ.). Publ. Astron. Soc. Jap.; 22: No. 2, 239-43(1970).

In atmospheres of late-type stars, metallic atoms are partially ionized. It is shown in this case that the coarse analysis of curve-of-growth gives different values of excitation temperature for different elements, and the ionization equation of Saha fails to give a unique set of ionization temperature and electron pressure values. It is therefore suggested that even in the coarse analysis, calculations based on model atmospheres should be employed. (auth)

7300 REMARKS ON THE H^- EQUILIBRIUM IN STELLAR ATMOSPHERES. Praderie, F. (Univ. of Colorado, Boulder). Astrophys. J.; 9: No. 1, 27-31(Aug 1971).

The importance of the charge-exchange process $H^- + H^+ \rightarrow H(1s) + H(ns,p,d)$ is compared to that of the associative detachment process. It is shown that (1) the first process is dominant in main-sequence A stars, and in lower-effective-temperature stars with gravity smaller than the main-sequence stars; (2) in the Sun, the charge-exchange process is of minor importance at every depth. (auth)

7301 FORMATION OF PLANETARY NEBULAE. Paczynski, B. (Inst. of Astronomy, Warsaw). Astrophys. Lett.; 9: No. 1, 33-4(Aug 1971).

Recent estimates of the rates of mass loss from Mira variables are sufficient to explain the origin of planetary nebulae. (auth)

7302 KINEMATICAL ANALYSIS OF THE CEPHEID VARIABLES. Takase, Bunshiro (Tokyo Univ.). Publ. Astron. Soc. Jap.; 22: No. 3, 255-76(1970).

The selected 146 Cepheids, for which accurate photometric measurements and also radial velocity and/or proper motion data exist, were used to determine a set of values concerning the motion of the stars and the distance scale of the Galaxy. Distances of these Cepheids were determined by combining photometric data with the period–luminosity and period–color relations derived by KRAFT (1961), FERNIE (1967b), and GEYER (1970). (W.D.M.)

7303 SPECTROGRAPHIC OBSERVATIONS OF IC 1805. Ishida, Keiichi (Tokyo Univ. Univ. of Texas, Austin). Publ. Astron. Soc. Jap.; 22: No. 3, 277-84(1970).

Spectral types are presented for 30 stars in the field of IC 1805 and radial-velocity observations were obtained for eight of them. The large ambiguity in the two or more alternative spectral types estimated from UBV values was removed for eight stars. Membership was examined for forty individual stars using spectral types and various data. A detailed correction for interstellar absorption is given by dividing the absorption into the foreground (R = 3.0) and the internal (R = 5.0) absorptions of the cluster. The true distance moduli of the probable member stars show remarkable coincidence between 10.8 and 11.5. (auth)

7304 THEORETICAL STUDIES ON STELLAR STABILITY. III. THERMAL INSTABILITY OF A SHELL SOURCE MODEL. Unno, Wasaburo (Tokyo Univ.). Publ. Astron. Soc. Jap.; 22: No. 3, 299-311(1970).

Thermal instability of a shell-source model was analytically studied on the basis of the general method for stellar stability developed in Paper I (Publ. Astr. Soc. Japan, 20, 356, 1968). Radiative energy transport was assumed, at least in the neighborhood of the nuclear-burning shell. Five parameters were introduced to represent different characteristic behavior of entropy perturbation in the envelope, the shell, and the core. These parameters, as well as the corresponding expression for the pressure perturbation, were determined variationally and then the growth rate of the perturbation was calculated. A necessary condition for instability is either that the shell is in electron degeneracy or that the thickness of the shell in units of local-pressure scale height is smaller than $0.22\, V_1$, V_1 being the radius-to-scale-height ratio at the shell. The latter condition is satisfied for nuclear burning, which is highly sensitive to temperature insofar as the shell source is distinctly formed. For the proton–proton reaction, however, it is required that the shell be situated very far away from the center. The growth rate of instability was found to be about $0.24\, [(\partial \ln \epsilon/\partial \ln T)_P + 0.12\, (\partial \ln \kappa/\partial \ln T)_P - 0.48]/\tau_S$, where τ_S is the time scale of heating in the shell, ϵ is the energy generation rate, and κ is the opacity. The large values of $(\partial \ln \epsilon/\partial \ln T)_P$, therefore, make the shell-source model unstable. (auth)

7305 MODEL FOR A SHELL STAR, ZETA TAURI. Nariai, Kyoji (Tokyo Univ.). Publ. Astron. Soc. Jap.; 22: No. 3, 313-16(1970).

The system velocity of the spectroscopic binary shell star ζ Tauri is known to vary with a period of 7 years and with a semi-amplitude of 70 km sec. A trial was made to interpret this variation of the system velocity, assuming that there is a large-scale circulation outside the photosphere and also that the period of the precession is double the above value. (auth)

7306 FORMATION OF W URSAE MAJORIS STARS. Okamoto, Isao; Sato, Koichi (International Latitude Observatory of Mizusawa, Japan). Publ. Astron. Soc. Jap.; 22: No. 3, 317-33(1970).

The formation of W UMa-type contact binaries is discussed on the basis of the theory of braking of orbital motion. The internal structure of the component stars during the wholly convective phase in the pre-main-sequence may be expressed by a rotating polytrope with an index of 1.5 if tidal deformation is neglected.

A Schatzman-type mechanism is applied as the means of loss of angular momentum, and the synchronized rotation of the components with the orbital revolution is also assumed. It is shown on the basis of the Roche model that, when the dissipation of angular momentum continues after contact, the greater amount of mass for the mass ratio nearer to unity is transferred from the less-massive to the more-massive component. A qualitative explanation is given for observed smaller mass ratios than unity. (W.D.M.)

7307 INFRARED POLARIZATION OF THE PECULIAR M-TYPE VARIABLE VY CANIS MAJORIS. Hashimoto, Jun-ichiro; Maihara, Toshinori; Okuda, Haruyuki; Sato, Shuji (Kyoto Univ.). Publ. Astron. Soc. Jap.; 22: No. 3, 335-40(1970).

The irregular M-type variable VY Canis Majoris was observed to be rather strongly polarized in the infrared region. The degrees of polarization at 1.67 microns and 2.25 microns are 5.1 ± 0.5% and 2.9 ± 0.5%, respectively. Polarization may be caused by scattering of a thick dust layer surrounding the star. (auth)

7308 POSITIONS OF GLOBULAR CLUSTER STARS IN THE PHYSICAL H-R DIAGRAM. Osborn, Wayne Henry. New Haven; Yale Univ. (1971). 224p. University Microfilms Order No. 71-29,714.

Thesis.

The David Dunlap Observatory (DDO) intermediate-band photometric system was used to observe late-type globular cluster stars for the purpose of obtaining physical data suitable for comparison with the predictions of theoretical Population II evolutionary calculations. The system was calibrated such that the DDO colors of any star may be used to determine its [Fe/H], its effective temperature, and its surface gravity. These quantities were derived from observations of several red giant branch, horizontal branch, and asymptotic branch members in each of the clusters M3, M5, M10, M13, and M92. By adopting distance moduli for the clusters, absolute magnitudes and estimates of the masses of the observed stars were also obtained. From the data, mean [Fe/H] values for the five clusters of −1.01 for M3, −0.68 for M5, −1.44 for M10, −1.69 for M13, and −1.96 for M92 (with errors of ±0.3) were derived. Evidence was found that the masses of horizontal and asymptotic branch stars are systematically lower than those for red giant branch members. Two of the stars investigated were found to have anomalously strong CN band strength. A star that appears to have a considerably lower surface gravity than would be expected for a globular cluster star of its temperature was discovered. It is shown that observations with the DDO system are well suited for separating cluster members from field interlopers. The observational results were compared with the predictions of two Population II evolutionary tracks and in general the agreement was good. (Diss. Abstr. Int., B)

7309 GLOBULAR CLUSTERS NGC 1851 AND NGC 2808. Alcaino, G. (Univ. Catolica de Chile, Santiago). Astron. Astrophys.; 15: No. 3, 360-7(Dec 1971).

A BV photographic investigation of the globular clusters NGC 1851 and NGC 2808 was carried out at the Cerro Tololo Inter-American Observatory (CTIO) with a 1.5-m reflector and the plate material was reduced with the iris-photometer of the European Southern Observatory. For NGC 1851, 117 stars were calibrated photographically from a photoelectric sequence of 32 stars previously obtained by the author at CTIO. From a poorly defined horizontal branch at V = 15.8 at the limit of photometry, an apparent distance modulus of (m − M) app = 15.30 was estimated. The reddening was E (B − V) = 0.14. The true distance modulus was $(m - M)_0 = 14.88$. The distance is 9460 pc from the Sun and 5430 pc from the galactic plane. The giant branch rises 2.35 magnitudes above the horizontal branch at $(B - V)_0 = 1.4$, characteristic of intermediate metallicity. For NGC 2808, 255 stars were calibrated photographically from 57 stars of two photoelectric sequences obtained at CTIO by different observers. As in the previous case, from a hypothetical horizontal branch estimated at V = 15.8, an apparent distance modulus of (m − M) app = 15.30 was deduced. The reddening was E (B − V) = 0.34. The true distance modulus was $(m - M)_0 = 14.28$. The distance is 7180 pc from the Sun and 1370 pc from the galactic plane. The giant branch rises 2.4 magnitudes above the horizontal branch at $(B - V)_0 = 1.4$, characteristic of intermediate metallicity. (auth)

7310 MEMBERSHIP OF THE OPEN CLUSTER NGC 6811. Sanders, W. L. (Univ. of Chicago). Astron. Astrophys.; 15: No. 3, 368-73(Dec 1971).

Probabilities of membership, based on relative proper motions, for 296 stars in the field of NGC 6811 are given. The cluster proper motion dispersion (m.e.) of 0.0007″ yields 97 probable members. (auth)

7311 OPEN CLUSTERS NGC 6613 (M 18) AND NGC 6716. Lindoff, U. (Lund Observatory, Sweden). Astron. Astrophys.; 15: No. 3, 439-49(Dec 1971).

UBV magnitudes were determined for stars in the open clusters NGC 6613 and NGC 6716, using a combination of photoelectric and photographic photometry. Spectral classes for the brighter stars were determined from slit spectra and objective prism plates. The absorption was determined to 1.4m in front of NGC 6613 and to 0.4m in front of NGC 6716. Their respective distances are 1250 and 600 pc. NGC 6613 is a young cluster, NGC 6716 is of medium age. (auth)

7312 REVISED INDICES FOR SOME G AND K DWARF STARS, ON THE SIX-COLOR SYSTEM OF THE LICK OBSERVATORY. Rousseau, J. (Observatoire, Lyon). Astron. Astrophys.; 15: No. 3, 468-70(Dec 1971).

For most of the G and K dwarf stars measured by Stebbins and Whitford (1945) the B − G index is found to be too small by a mean value of 0.08. (auth)

7313 EVAPORATION OF DIRTY ICE PARTICLES SURROUNDING EARLY-TYPE STARS. I. THE ORION NEBULA. Isobe, Syuzo (Tokyo Univ.). Publ. Astron. Soc. Jap.; 22: No. 4, 429-45(1970).

The ice particle model of dust grains is justified in the Orion Nebula, considering various observations, i.e., (1) interstellar absorption shows a minimum value at the center of the Nebula and a maximum at about three minutes of arc from the central exciting star; (2) oxygen atoms in the gaseous phase are abundant in the central region but deficient in the outer region; and (3) the abnormality of the reddening curve in the central region is predicted quite well by the theoretical calculation. (auth)

7314 ENERGY DISTRIBUTION AROUND THE LIGHT MAXIMUM OF NOVA SERPENTIS 1970. Kodaira, Keiichi (Tokyo Univ.). Publ. Astron. Soc. Jap.; 22: No. 4, 447-53 (1970).

Scanner observation revealed that the continuous energy distribution (3500 to 5300 Å) around the light maximum of Nova Serpentis 1970 can be well represented by that of a yellow supergiant model (T_{eff} = 5,700°K, log g ≃ 1.2) calculated by Parsons (1969), when the observational results are corrected for interstellar reddening. One day after the maximum, the nova emitted 3×10^{35} erg · sec^{-1} in Hβ with the Balmer decrement Hγ/Hβ of about 0.66, and the Balmer continuum was found to be intensified by 0.4 mag at 3600Å relative to that occurring one day before the maximum. (auth)

7315 INTERPRETATION OF THE OBSERVED CHROMOSPHERIC RADIAL VELOCITIES OF THE K-TYPE COMPONENT OF ZETA AURIGAE. Saito, Mamoru (Tokyo Univ.). Publ. Astron. Soc. Jap.; 22: No. 4, 455-74(1970).

Motions of the chromospheric H I gas of the K-type component along the line of sight to the B-type component were studied by taking into account (i) acceleration of the chromospheric H I gas by Lyman quanta from the B-type companion, (ii) mass ejection of the K star, and (iii) rotation of the chromosphere of the K star. In the egress-side chromosphere, the H I−H II boundary is an ionization front and thus the H I gas existing along some range of the boundary is accelerated and forms a condensed H I region there. The range of the condensed H I region in the chromospheric height is determined by the rate of mass ejection of the K star. In order to explain the mean variation of the radial velocities observed during the egress, the K star should be ejecting matter at the rate of about $1 \times 10^{-8}\ M_{\odot}$/year and the chromosphere of the K star should be rotating with about 5/r km/sec where r is the radial distance in units of the radius of the K star. The radial velocities observed during the ingress can be explained as being caused by the rotation of the undisturbed chromosphere and nonsteady motion of the chromospheric gas clouds. (auth)

7316 ENVELOPE MODELS OF HYDROGEN-DEFICIENT STARS. Nariai, Kyoji (Tokyo Univ.). Publ. Astron. Soc. Jap.; 22: No. 4, 475-81(1970).

The envelope models of hydrogen-deficient stars were calculated utilizing the mixing length theory. Models were calculated inward until reaching a depth where the convective transport is large and the value of the entropy is approximately constant. The Hayashi-limiting lines were determined for specific values of mass. The limiting lines for helium-rich composition (H : He : C : Fe = 10 : 1000 : 10 : 1 in number) are located to the left of and parallel to those for normal composition with $\Delta \log T_e = 0.20$. The limiting lines for carbon-rich composition (H : He : C : Fe = 1 : 1 : 1000 : 10 in number) are located to the left of the helium-rich limiting lines.

The results permit the hypothesis that the hydrogen-deficient star R CrB, which is located to the right of the carbon-rich limiting line, contains helium as the most abundant element. (auth)

7317 DISAPPEARANCE OF THE DISPLACED ABSORPTION LINE OF H ALPHA IN THE SPECTRUM OF THE HYDROGEN-DEFICIENT STAR UPSILON SAGITTARII. Nariai, Kyoji (Tokyo Univ.). Publ. Astron. Soc. Jap.; 22: No. 4, 559-60(1970).

The displaced Hα line in the spectrum of υ Sgr, which corresponds to a velocity of −300 km/s and which has been observed for the last twenty years between 0 and 40 days of the star's orbital phase, could not be observed in July 1970. This means the star is in a quiet state now. The preceding quiet period was from 1929 to 1950. (auth)

7318 MAGNETIC FIELDS OF WHITE DWARFS. Chanmugam, G.; Gabriel, M. (Univ., Liege). Astron. Astrophys.; 16: No. 1, 149-52(Jan 1972).

The time scale of decay for the magnetic fields of white dwarfs was determined for dipolar and toroidal field configurations, taking into account the nonuniform conductivity and effects due to cooling. It is shown that it is unlikely that field decay could be the cause of nonobservability of magnetic fields in some white dwarfs. Alternative causes are discussed. (auth)

7319 PROPOSED TEST OF THE SUPERMETALLICITY OF MU LEONIS. Wallerstein, George (Univ. of California, Berkeley). Astron. Astrophys.; 16: No. 1, 153-4(Jan 1972).

It is suggested that measurement of the central depth of the Ca I line at λ6572 and the Mg I line at λ4571 should yield the ratio of boundary temperature to effective temperature for K giants and hence test the mechanism suggested by Strom, Strom, and Carbon for the enhancement of strong lines in μ Leo and other super-metal-rich stars. (auth)

7320 DISTANCES OF BRIGHT STARS IN STELLAR RING 274. Kolesnik, L. N. (Main Astronomical Observatory, Kiev). Astron. Astrophys.; 16: No. 1, 155-7(Jan 1972).

BV photometry and spectral types of 110 stars in the field around stellar ring 274 were used to determine the distances of bright stars in the ring. Color excesses E_{B-V} were plotted as a function of the uncorrected distance modulus $V - M_v$. The absorption A_v was 2m at 1.1 kpc. Distances were calculated for 7 stars that might be members of the stellar ring. It is likely that four high-luminosity stars are at the same distance. However stars of spectral types A0 to F2 are evidently background stars. (auth)

7321 SPECTROSCOPIC STUDY OF oPER. Foy, R. (Observatoire de Paris, Meudon, France). Astron. Astrophys.; 16: No. 1, 108-14(Jan 1972).

The spectroscopic binary oPer was analyzed in order to ascertain whether it is a βCep star, and to determine, by means of an improvement of Petrie's method (1939), spectral types and absolute magnitudes of the two components; from that, masses, radii, and absolute values of the orbital parameters are obtained. These data permit the discussion of the anomalous proper motion of oPer with respect to the association II Per, of which oPer has been considered as a member (Blaauw, 1952). oPer is found not to be a member of the association II Per. (auth)

7322 SPECTRUM OF HR 2902 IN 1971. Jaschek, Mercedes; Brandi, Estela (Observatorio Astronomico, La Plata). Astron. Astrophys.; 16: No. 1, 115-17(Jan 1972).

The spectral features of HR 2902 in 1971 are described, with special emphasis upon the far-ultraviolet. A rapidly evolving shell is evident, which at this phase reproduces the spectral appearance of 1947−48 and agrees well with orbital predictions. (auth)

7323 MEMBERSHIP OF NGC 6940 AND IC 1805. Sanders, W. L. (Yerkes Observatory, Williams Bay, Wis.). Astron. Astrophys.; 16: No. 1, 58-9(Jan 1972).

Membership probabilities for stars in the field of NGC 6940 and revised probabilities for those in the field of IC-1805 are presented. (auth)

7324 MODELS FOR CONTACT BINARIES. Biermann, Peter (Univ., Goettingen, Ger.); Thomas, H.-C. Astron. Astrophys.; 16: No. 1, 60-5(Jan 1972).

Zero-age models for contact binaries were constructed, using a method that allows for different adiabatic constants in the convective envelopes. The exchanged luminosity was determined by the condition that the component stars fill their respective Roche lobes and are thereby in contact. The models reproduce the main features of the period−color diagram. It is noteworthy that the theoretical models cover most of the range of periods observed for W UMa systems. The inclusion of the effects of gravity darkening is not fully sufficient to reproduce the light curves observed for W UMa systems. (auth)

7325 THERMODYNAMICS OF WHITE-DWARF MATTER. II. Shaviv, G. (Tel Aviv Univ., Ramat Aviv, Israel); Kovetz, A. Astron. Astrophys.; 16: No. 1, 72-6(Jan 1972).

An equation of state is constructed for a dense plasma in which the electrons are strongly degenerate. In addition to the perfect gas and noninteracting fermion terms for the ions and electrons, respectively, one has the classical Coulomb and the Thomas−Fermi corrections; these are of first and second order in $Z^{2/3}\alpha$, where Z is the charge number and α the fine structure constant. In addition, there is the exchange interaction between the electrons and a quantum correction due to the noncommutation of the ionic coordinates and momenta; the latter is the counterpart, in a disordered state, of the harmonic vibration terms (Kovetz and Shaviv, 1970, Paper I) in a lattice. This equation of state was used together with the one obtained in Paper I to determine the conditions for a phase transition between liquid and solid. Some numerical examples for this are given. (auth)

7326 SPECTRAL LINES IN THE Be I ISOELECTRONIC SEQUENCE. Nussbaumer, H. (Meudon Observatory, France). Astron. Astrophys.; 16: No. 1, 77-80(Jan 1972).

Atomic data for C III, N IV, O V, Ne VII, Na VIII, Mg IX, Si XI, S XII, Ca XV, and Fe XXIII are discussed. Transition probabilities were calculated and examples of excitation cross sections calculated with the impact parameter method are given. The probabilities of the intercombination transition $2s^2\ {}^1S_0 - 2s2p\ {}^3P_1^0$ differ substantially from those given in earlier publications; large differences from standard reference values are also found for ordinary dipole transitions. (auth)

7327 SURFACE TEMPERATURES AND CURVES OF GROWTH FOR POPULATION I AND POPULATION II STARS. Boehm-Vitense, Erika (Univ. of Washington, Seattle). Astron. Astrophys.; 16: No. 1, 81-4(Jan 1972).

The dependence of the curve of growth on metal abundance was studied by comparing the solar curve of growth with that of a star with the same effective temperature and gravity but a metal content reduced by a factor 100 and also with that of a giant with reduced metal abundance. The $T(\tau)$ turned out to be essentially the same for the models with the same T_{eff}, therefore the curves of growth (computed for Fe I and Fe II and Doppler broadening only) are also the same for the stars with the same T_{eff} and g but different metal abundances. A theoretical discussion of this result is given. (auth)

7328 CONTRIBUTION TO THE DETERMINATION OF THE EFFECTIVE TEMPERATURE OF A-TYPE STARS. Baylac, M. O. (Meudon Observatory, France). Astron. Astrophys.; 16: No. 1, 85-94(Jan 1972).

The possibility is demonstrated of determining effective temperatures of A stars of different effective gravities with an accuracy of about 0.02 in θ_e, using the V−I index of Johnson for unreddened stars. A comparison was made between the theoretical and observational results; the influence of hydrogen and metallic line blocking, convection, rotation, and interstellar and atmospheric absorption were taken into account. (auth)

7329 SHORT-PERIOD VARIABLE STARS. IV. PERIODS OF DELTA SCUTI STARS. Valtier, J. C. (Observatoire, Nice). Astron. Astrophys.; 16: No. 1, 38-43(Jan 1972).

A method of analyzing short and nonequi-spaced light curves is described and used to study all the published photometric data of Delta Scuti stars. A set of homogeneous results on periods is given, but of 34 stars studied, four are called "Delta Scuti" on a very poor basis and nine exhibit more than 30 minutes difference between the different determinations of periods. (auth)

7330 GLOBULAR STELLAR CLUSTERS WITH AN INHOMOGENEOUS STELLAR COMPOSITION. Bagin, V. M. Sov. Astron. AJ (Engl. Transl.); 15: No. 3, 506-7(Nov-Dec 1971). Translated from Astron. Zh.; 48: No. 3, 643-4(May-Jun 1971).

In an extension of the results of a previous study, a complete system of first integrals was found for a particular system of equations for the case in which there is an arbitrary number of stellar groups in the cluster. An explicit expression was obtained for the partial mass densities of the stellar groups, and the solution was studied. It followed from this solution that stars of relatively small mass will systematically displace relatively massive stars at the periphery of the cluster according to this model; this is in qualitative agreement with observation. (auth)

7331 SEARCH FOR MONOCHROMATIC 927-MHz RADIO EMISSION FROM NEARBY STARS. Troitskii, V. S.; Starodubtsev, A. M.; Gershtein, L. I.; Rakhlin, V. L. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 3, 508-10(Nov-Dec 1971).
Translated from Astron. Zh.; 48: No. 3, 645-7(May-Jun 1971).

A search for narrow-band emission from certain stars up to tens of light years from the Earth is reported. Signals were sought in a 2-MHz band around 927 MHz by means of a 25-channel detector, each channel of which had a passband of 13 Hz and a noise temperature of 60°K. An antenna 15 m in diameter was used. No monochromatic emission above 2×10^{-21} W/m^2 was found at this wavelength during the search. (auth)

7332 SPECTROPHOTOMETRY OF THREE FILAMENTARY NEBULAE. Lozinskaya, T. A.; Esipov, V. F. (Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 3, 353-7(Nov-Dec 1971).
Translated from Astron. Zh.; 48: No. 3, 449-54(May-Jun 1971).

A grating spectrograph and a contact electronic image converter mounted at the Cassegrain focus of the 125-cm reflector were used to obtain spectrograms of the filamentary nebulae NGC 2359, S22, and the Crab Nebula. The relative intensities of the Hα, Hβ, [N II], [S II], and [O III] lines were determined for individual filaments in these nebulae. The intensities of the [N I] and [O I] lines in S22 and the He I and He II lines in the Crab were also measured for a number of filaments. (auth)

7333 VELOCITY FIELD OF PLANETARY NEBULA NGC 6853. Doroshenko, V. T. (Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 3, 358-62(Nov-Dec 1971).
Translated from Astron. Zh.; 48: No. 3, 455-60(May-Jun 1971).

The planetary nebula NGC 6853 was examined in the Hα line with a Fabry–Perot interferometer. The radial velocity of the nebula as a whole is −45 ± 2 km/sec relative to the Sun. The expansion velocity of the nebula ranges from 30 km/sec near the center to 90 km/sec at the periphery. The mean half-width of the H_α emission line is 41.5 ± 4.5 km/sec. The value obtained for the expansion velocity, together with a reasonable estimate for the distance to the nebula, yields an angular expansion rate of about 5 to 6″ per century, in agreement with Chudovicheva's results for NGC 6853. (auth)

7334 HALOS AROUND BLACK HOLES. Shvartsman, V. F. (Astronomical Inst., Moscow. Inst. of Applied Mathematics, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 3, 377-84 (Nov-Dec 1971).
Translated from Astron. Zh.; 48: No. 3, 479-88(May-Jun 1971).

Black holes—bodies confined within their gravitational radius—will necessarily attract interstellar gas. If $M_{hole} > 0.03\ M_\odot$, at least 0.01 mc^2 of the infalling material should be converted into radiation. The corresponding luminosity would be of order 10^{32} $(M/10\ M_\odot)^{3/2}(\rho_{gas}/10^{-24}\ g \cdot cm^{-3})^{1/2}$ erg/sec, and would result from synchrotron radiation by magnetized plasma that would be heated to $T \approx 10^{12}$°K during the infall process. The spectrum would have a very mild slope extending from optical to radio wavelengths. Black holes might be observable as faint optical stars with no lines; they could be distinguished by intensity fluctuations on a time scale $\Delta t \approx 10^{-5}$ to 10^{-2} sec, with no periodic component whatever. In many cases accretion by massive holes ($10 \gtrsim M \gtrsim 10^4\ M_\odot$) should engender hard radiation (x and/or γ rays) exhibiting a flare behavior on a time scale ranging from a few months to tens of years; the peak intensity should be 10 to 100 times the synchrotron intensity. This phenomenon is associated with the turbulence of the interstellar medium: the angular momentum of the gas would halt the infall near the gravitational radius of the hole, and the momentum would be "annihilated" when the object moves into the adjacent turbulence cell. Only if $M > 10^6\ M_\odot$ would the angular momentum of the gas be capable of diminishing the mass falling into an isolated hole (that is, its luminosity). During infall toward a hole of $M \approx 10^5\ M_\odot$, the gas will initially remain cool ($T \approx 5000$°K) and will display an emission spectrum similar to the optical spectra of quasars. Because of accretion, a hole in a binary-star system might be observable as a visible secondary component. Accretion by a hole can be distinguished observationally from accretion by a neutron star. Possible candidates for black holes that may actually have been detected include certain type-Dc white dwarfs, the γ-ray star Sgr γ-1, the x-ray flare stars Cen X-2 and Cen X-4, and such objects as Sco X-1 and Cyg X-2. (auth)

7335 ROTATING SUPERDENSE CONFIGURATIONS IN GENERAL RELATIVITY. Arutyunyan, G. G.; Sedrakyan, D. M.; Chubaryan, E. V. Sov. Astron. AJ (Engl. Transl.); 15: No. 3, 390-5(Nov-Dec 1971).
Translated from Astron. Zh.; 48: No. 3, 496-504(May-Jun 1971).

The fundamental integral parameters of rotating superdense equilibrium configurations were evaluated in the approximation of small angular velocities (the problem was solved in the Ω^2 approximation). The masses of rotating configurations are shown to differ only slightly (by ≈14 to 20%) from the masses of the corresponding static configurations. The behavior of the mass curve remains unchanged throughout the entire range of central densities. As expected, the masses of rotating configurations exceed the masses of nonrotating ones, except that for a hypothetical configuration with infinite central density the opposite situation was found. The polar and equatorial radii vary by 30 to 33%. Values were also computed for the relativistic moment of inertia, the quadrupole moment, and the maximum angular velocity possible without shedding of material. (auth)

7336 EXISTENCE OF STELLAR SYSTEMS WITH POSITIVE TOTAL ENERGY. Rybakov, A. I.; Kalinina, E. P.; Kholopov, P. N.; Duboshin, G. N. (Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 3, 406-10(Nov-Dec 1971).
Translated from Astron. Zh.; 48: No. 3, 518-23(May-Jun 1971).

It must still be considered unproved that isolated stellar systems exist with positive total energy. A numerical integration of the equations of motion for the members of the Orion Trapezium indicates that these stars should be regarded simply as the most massive and brightest members of a stable star cluster, with their velocity dispersion determined by the mass of the cluster. The expansion effects observed in some stellar associations should not be considered signs that the systems are disintegrating, because their total masses are unknown. (auth)

7337 PROBABILITY OF BINARY-SYSTEM FORMATION THROUGH TRIPLE ENCOUNTERS. Agekyan, T. A.; Anosova, Zh. P. (Leningrad State Univ.). Sov. Astron. AJ (Engl. Transl.); 15: No. 3, 411-14(Nov-Dec 1971).
Translated from Astron. Zh.; 48: No. 3, 524-8(May-Jun 1971).

In a previous investigation (1969) the probability of binary-system formation through triple encounters was determined as a function of the ratio H of the system energy to the absolute value of the potential energy at the epoch of strongest triple interaction. It is here shown that the probability of binary formation depends in approximately the same way on the quantity H*, which differs from H in that it is evaluated for the "aimed" velocity vectors rather than the true motion, and can be determined as soon as the initial conditions of the encounter are prescribed. The previous method permitted a wide range of H values to be obtained, but the H distribution does not agree with the distribution for actual triple encounters in stellar systems. A natural distribution of encounter parameters is adopted for analyzing possible triple encounters. Integrations were performed numerically for 5000 random initial conditions specifying encounters inside a sphere of radius $r_1 = 2Gm/(\sqrt{3V^2})$, and for 5000 encounters inside a sphere of radius $r_2 = 5r_1$. A total of 513 binary systems were found to be formed inside the first sphere through triple encounters, and 114 systems inside the second sphere. The H dependence of the probability of binary-system formation was confirmed. (auth)

7338 DISTRIBUTION OF STARS OF DIFFERING MASS IN THE PLEIADES. Kholopov, P. N. (Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 3, 415-18(Nov-Dec 1971).
Translated from Astron. Zh.; 48: No. 3, 529-33(May-Jun 1971).

An analysis of the spatial distribution of stars with different masses in the Pleiades (including flare variables) confirms the relation obtained previously between the quantities $D_f = |\lg(f_c/f_0)|$ and $\log \overline{\mathscr{M}}$, where $\overline{\mathscr{M}}$ is the mean mass of the stars in a given group, and f_c, f_0 are the mean space densities of the stars of that group in the outer coronal region and the central nuclear zone of the cluster. The total mass of all Pleiades members brighter than $M_V = +10.5$ within the cluster radius (3.5° or 7.7 pc) is 370 $\mathscr{M}_\odot$. The corresponding mean density of the cluster is 0.19 $\mathscr{M}_\odot/pc^3$. (auth)

7339 OBLIQUE-ROTATOR MODEL FOR THE BRIGHTNESS AND COLOR VARIABILITY OF MAGNETIC Ap STARS.

Khokhlova, V. L. (Astronomical Council, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 3, 419-28(Nov-Dec 1971).
Translated from Astron. Zh.; 48: No. 3, 534-45(May-Jun 1971).

A discussion is given on the factors that might be responsible for the observed brightness and color variations of the magnetic Ap stars, assuming that the variability period coincides with the star's rotation period and that intrinsic changes in the surface conditions occur on a time scale much longer than the rotation period. The variability of the peculiar-element and hydrogen lines is shown to be insufficient to explain the brightness and color variations. The possibility is considered that the U, B, V brightness variations might arise from differences in the atmospheric structure (differing temperature gradients) above different areas of the stellar surface. An alternative explanation is examined, in which the brightness variations would result from a nonspherical figure for the star, due in turn to a strong internal magnetic field. In some cases an excessive difference between the equatorial and polar radii of the star would be required. A combination of both interpretations is possible: nonuniform physical conditions at the surface, and an asymmetrical figure for the star. (auth)

7340 DIFFERENTIAL LINE SHIFTS IN SPECTRUM OF THE SUPERGIANT β ORIONIS. Chentsov, E. L.; Snezhko, L. I. (Special Astrophysical Observatory, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 3, 429-31(Nov-Dec 1971).
Translated from Astron. Zh.; 48: No. 3, 546-8(May-Jun 1971).
The observed pattern of differential line shifts in the spectrum of β Ori can be explained by a radial expansion of the star's atmosphere. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstract 6827.

7341 (UCRL-51090) SOFT X-RAY SURVEY FROM THE GALACTIC CENTER TO VELA. Hill, R. W.; Burginyon, G.; Grader, R. J.; Palmieri, T. M.; Seward, F. D.; Stoering, J. P. (California Univ., Livermore. Lawrence Radiation Lab.). 12 Jul 1971. Contract W-7405-eng-48. 18p. Dep. NTIS.
A 640-cm^2 proportional counter system, sensitive from 0.2 to 12 keV, was used to survey the galactic plane from Sagittarius to Vela. Spatial resolution was 1 deg at best. The soft x-ray sky (<1 keV) is dominated by a region of strong emission in the vicinity of Vela X and has a quite different appearance than the sky viewed at photon energies a few keV higher. Many sources were located in one dimension (i.e., seen on one scan only) in the direction of the galactic center. Some of these positions agree well with those of previous experiments. Two strong sources—GX 292-0 or Cen 3, and GX 322+0 or Cir 1—were seen on two scans and were located to within 0.2 deg^2. Another weaker source—GX 296-2 or Cen 5—was seen on two scans and was located to within 0.6 deg^2. A definite source of soft x rays was seen which seems to coincide with the object eta Carinae. The source Nor 1 was found to emit a greater flux of soft x rays than other surrounding objects relative to its overall strength. Spectra were derived for all sources and numbers are given for interstellar material in the line of sight. (auth)

7342 OHIO SURVEY BETWEEN DECLINATIONS OF 40^0 AND 63^0 NORTH. Brundage, R. K.; Dixon, R. S.; Ehman, J. R.; Draus, J. D. (Ohio State Univ., Columbus). Astron. J.; 76: No. 9, 777-89(Nov 1971).
A 1415-MHz continuum survey with the Ohio State University (OSU) 110-m by 21-m radio telescope was made between declinations of 40° and 63° north covering 4407 deg^2 of sky. Results are presented by 67 maps of the regions surveyed and by a list of 3475 sources at or above 0.18 f.u. Of these sources, 2388 are previously uncatalogued. This is the fifth installment of the Ohio survey. The five installments include a total of 11,808 sources in 5.87 steradians of sky. (auth)

7343 FLUX DENSITY SCALE FOR RADIO SOURCES AT 81.5 MHz. Scott, P. F.; Shakeshaft, J. R. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc.; 154: No. 4, 19P-23P (1971).
The flux densities at 81.5 MHz of 13 radio sources were carefully measured with respect to those of Cas A and Cyg A. It was found that the flux densities of the weaker sources were systematically larger, by 22 ± 5% on average, than the values interpolated from the spectra listed by Kellermann, Pauliny-Toth, and Williams [Astrophys. J., 157: 1 (1969)]. This was consistent with earlier suggestions that the KPW scale is too low for frequencies less than 750 MHz and implied that the apparent flattening of the spectra of the majority of sources at about this frequency may be largely removed. (auth)

7344 NEW COMPLEXITIES FOR THE COSMIC CHEMIST. Barrett, A. H. (Massachusetts Inst. of Tech., Cambridge). Comments At. Mol. Phys.; 11: No. 6, 165-70(Feb-Mar 1971).
It is stated that during 1970 the number of known interstellar molecules increased from 6 to 12 different species. The newly found molecules include CO, H_2, cyanoacetylene (HC_3N), CH_3OH, and perhaps formic acid (H_2CO_2). An account is given of the discovery of these compounds in space. H_2 was discovered at uv wavelengths, whereas the remaining discoveries were made at radio wavelengths. The discoveries of some of the new species are particularly significant since they were first made at mm wavelengths and promise exciting future developments; techniques adopted are described. The case of CO is discussed in detail and among conclusions reached is that the abundance of C and O is more than three times that predicted from accepted cosmic abundances, even if it is assumed that all the C and O exists as CO. The latter has also been radio detected in the infrared star IRC + 10216. The discovery of HC_3N followed quickly on that of CN and HCN. During studies of HCN an unidentified line was detected at 89.190 GHz in several sources; it was given the name X-ogen. CH_3OH was detected in August 1970 at 834 MHz in the galactic center sources Sag A and B.2, and possibly H_2CO_2 at 1638.805 MHz in the direction of Sag B.2. 12 references. (UK)

7345 ABUNDANCE RATIOS FROM THE ABSORPTION SPECTRUM OF THE QUASAR PKS 0237-23. Hartwick, F. D. A. (Univ. of Victoria, British Columbia). Astrophys. J.; 170: No. 3, L127-9(15 Dec 1971).
Using the measurements of absorption features in the spectrum of the quasar PKS 0237−23 by Bahcall, Greenstein, and Sargent, it was found that N(C)/N(Si) ~ 2.6 and N(Al)/N(Si) ~ 0.04 to within factors of 3. On the basis of recent explosive-nucleosynthesis calculations and observations of objects within the Galaxy, it was concluded that PKS 0237−23 is chemically old. (auth)

7346 OBSERVATIONS OF OJ 287 BETWEEN 0.36 AND 3.4 μm. Dyck, H. M. (Kitt Peak National Observatory, Tuscson, Ariz.); Kinman, T. D.; Lockwood, G. W.; Landolt, A. U. Nature (London) Phys. Sci.; 234: No. 47, 71-2(22 Nov 1971).
Previous studies of this radio source are first briefly reviewed, followed by a description of measurements of the energy distribution in the optical and infrared regions and some further measurements of polarisation. Collected data are tabulated. From photographic monitoring it appeared that the reported rapid variations are real, including rapid changes of linear polarisation. In order to determine the energy distribution, photoelectric observations were made in wavebands in the range 0.36 to 1.04 μm, in addition to observations with a PbS detector in the range 1.25 to 3.4 μm during the photographic monitoring. No definite evidence was obtained that the energy distribution changed during the observing period (Sep. to Oct. 1971), and of known large-amplitude variable sources, OJ 287 seems to have the flattest energy distribution. The observations suggested that OJ 287 may be bright enough in the infrared to obtain flux and polarisation measurements of sufficient accuracy to make useful comparisons with observations at optical and the shorter radio wavelengths. (UK)

7347 NEW GALACTIC H_2O SOURCES ASSOCIATED WITH H II REGIONS. Turner, B. E. (National Radio Astronomy Observatory, Green Bank, W. Va.); Rubin, R. H. Astrophys. J.; 170: No. 3, L113-8(15 Dec 1971).
Eight new galactic H_2O emission sources were found in H II regions at positions all of which appear to coincide with Type-I OH emission. No H_2O emission was detected in 20 continuum sources which show OH in absorption, even though these sources all had apparent OH opacities of at least 0.15. These facts are discussed in terms of two possible pumping mechanisms for the H_2O and Type I OH emission. (auth)

7348 SECOND DECREASE IN PERIOD OF THE VELA PULSAR. Reichley, P. E.; Downs, G. S. (California Inst. of Tech., Pasadena). Nature (London) Phys. Sci.; 234: No. 46, 48(15 Nov 1971).
The first discontinuity in period of the Vela pulsar (PSR 0833-45) occurred between Feb 24 and March 3, 1969; the period then decreased by 208 ns and the rate of change of period increased by 1×10^{-15} ss^{-1}. A similar discontinuity occurred between Aug. 21 and Sept. 4, 1971, and preliminary analysis of the data indicated a period decrease of 179 ns, with a further increase of rate of change. The data reduction techniques are described. The fractional change in period was -2×10^{-6}, and estimates of the age of the pulsar must take such period changes into account if the changes are accompanied by fractional changes of $\sim 10^{-2}$. An age

estimate based on the ratio of the period to twice the rate of change gives 11,400 yr, but this estimate is increased considerably when allowances are made for discontinuities, and the pulsar could be as old as the supernovae remnant Vela X which apparently surrounds it. The estimate could be correct if the observed changes in period are apparent, and one cause of an apparent change could be planetary comparison to the pulsar. (UK)

7349 LUNAR OCCULTATION OBSERVATIONS OF PKS 1514-24 (= AP Lib). Kapani, V. K. (Tata Inst. of Fundamental Research, Bombay). Nature (London) Phys. Sci.; 234: No. 46, 49-50(15 Nov 1971).

It is stated that lunar occultation observations of PKS 1514-24 made with the Ooty radiotelescope at 326.5 MHz on Feb 18, 1971 indicated a radio position that does not agree with that determined by Hunstead (Nature, 233: 401(1971)), whose observations indicated that the radio and optical positions did not coincide. The former observations indicated that most of the radio emission emanates from a region coincident with the optical position measured by Hunstead. From the occultation observations it was also possible to study the radio structure with a resolution of 1 arc/s. The technique adopted and method of data reduction are described, and results discussed. (UK)

7350 INTERFEROMETRIC OBSERVATIONS OF PULSARS AT 2.7 AND 8.1 GHz. Huguenin, G. R. (Univ. of Massachusetts, Amherst); Taylor, J. H.; Hjellming, R. M.; Wade, C. M. Nature (London) Phys. Sci.; 234: No. 46, 50-1(15 Nov 1971).

Observations of 20 pulsars made during May 20 to 25, 1971, using the National Radio Astronomy Observatory Green Bank 3-element interferometer, are described. The principal aims of the observations were (1) to obtain accurate position measurements independent of pulse-timing considerations, (2) to determine the flux densities at 2.7 GHz, and for the strongest pulsars also at 8.1 GHz, and (3) to detect, or place upper limits on, any continuous nonpulsed radio emission from regions of small angular size near the pulsars. Seventeen of the pulsars were detected at 2.7 GHz and three at 8.1 GHz, which is believed to be the highest radio frequency at which pulsars have been observed. Details of the technique adopted are given and the principal results are summarized and compared with those of other authors, who used different techniques. The effect of deep interstellar scintillations on flux density measurements is mentioned. No significant nonpulsed emission at or close to a pulsar position was detected. The existence of extended sources, such as weak supernova remnants, larger than ~10 arc s could not, however, be ruled out. (UK)

7351 NONTHERMAL SHELL SOURCE CLOSE TO DIRECTION OF CP 1919. Goss, W. M. (Max Planck Inst. Fuer Radiostronomie, Bonn); Schwarz, U. J. Nature (London) Phys. Sci.; 234: No. 46, 52-3(15 Nov 1971).

Reference is made to Caswell and Goss (Astrophys. Lett., 7: 141(1970)) who discussed the possibility of a weak nonthermal source (G55.7 + 3.4) in the direction of CP 1919, having the following characteristics: (1) a nonthermal spectrum between 178 and 2,700 MHz, with spectral index $\alpha \approx 0.5$, (2) an overall angular extent of $15' \times 15'$, (3) displacement of the centroid from the pulsar position by 8′, and (4) an integrated flux of 0.7 f.u. at 2,700 MHz. The above authors point out a fundamental problem in assuming a physical relationship between this extended source and the pulsar—the distance and age discrepancies; these are discussed. The results of a high-resolution study of G55.7 + 3.4 at 1415 MHz made with the Netherlands Westerbook Synthesis radiotelescope are presented. The detailed structure of the source appears to be highly suggestive of a supernova remnant, but some serious problems in associating the extended source with the pulsar are discussed. A smoothed contour map of the observations is shown, indicating that the source has an overall shell structure, with the pulsar at the edge of the shell, at a distance of 8′ from its center. The inner region also contributes significantly to the total flux, which is ~0.8 f.u. It is considered most likely that the shell source is a new type of galactic object, arising either from the birth of the pulsar or from ejection of relativistic electrons in the later history of the pulsar. (UK)

7352 STRUCTURE OF NONTHERMAL RADIO SOURCE G55.7 + 3.4 IN THE DIRECTION OF CP 1919. Kundu, M. R.; Velusamy, T. (Univ. of Maryland, College Park). Nature (London) Phys. Sci.; 234: No. 46, 54(15 Nov 1971).

Reference is made to Caswell and Goss (Astrophys. Lett., 7: 142(1970)) who reported detection of an extended radio source, G55.7 + 3.4, at 2700 and 178 MHz in the direction of the pulsar CP 1919, and because of its nonthermal spectrum, proposed that it might be a galactic supernova remnant associated with the pulsar. These authors pointed out, however, that the age (5×10^4 yr), and distance (7.5 kpc) of this assumed supernova remnant, calculated from its observed parameters, did not agree with those (10^7 yr and 300 to 1,800 pc) of CP 1919, calculated from its observed period, its rate of slowing down, absorption studies, and dispersion measure. The present authors considered that the apparent association should not be regarded as a chance coincidence, and to investigate matters further they mapped the region of G55.7 + 3.4 at 11- and 21-cm wavelengths, using the 300-ft resurfaced National Radio Astronomy Observatory Green Bank telescope. Contour maps are shown, together with the flux density spectrum; the spectral index was 0.54. The structure and spectrum suggested that the source may, indeed, be a supernova remnant. The approximate distance and linear diameter of the source were estimated from the observed surface brightness and angular diameter, the values obtained being 7 kpc and ~40 pc, respectively: an upper age limit of 10^5 yr was also obtained. It was concluded from these observations that it could not be confirmed that G55.7 + 3.4 is associated with CP 1919. The position of the pulsar is far away from the center of the remnant, but it is possible that CP 1919 is a runaway pulsar. (UK)

7353 PERIOD–LUMINOSITY FUNCTION FOR PULSARS. Venugopal, V. R. (Tata Inst. of Fundamental Research, Cotacamund, India). Nature (London) Phys. Sci.; 234: No. 46, 55(15 Nov 1971).

Reference is made to Cavallo (Nature Phys. Sci., 231: 35(1971)) who considers it possible that estimates of pulsar distances based on dispersion measures are unreliable and introduce a tentative period–luminosity relation for pulsars. The present author considers that the validity of Cavallo's relation seems doubtful because the distances derived from it are not in agreement with more directly determined pulsar distances. The cases of CP 0329, AP 2015 + 28, PSR 1749-28, NP 0527, and NP 0532 are discussed as examples. A conclusion made by Cavallo is that the known pulsars tend to be confined to a single spiral arm, which distribution is different from that obtained when distances are derived from dispersion measures; in the latter case, the pulsars appear to be distributed in two spiral arms. (UK)

7354 MAGNETIC FIELD EFFECTS ON THE OUTERMOST CRUSTS OF PULSARS. Mueller, R. O.; Pau, A. R. P.; Spruch, L. (Univ. of New York). Nature (London) Phys. Sci.; 234: No. 45, 31-2(8 Nov 1971).

It is stated that magnetic (B) field effects can readily be incorporated into pressure–density equations of state used in pulsar calculations by replacement of the normal Thomas–Fermi model of "crushed" atoms by the TF-like model for isolated atoms that includes the B field extended to incorporate the effects of pressure. The variational formulation of this TF-like statistical model is more convenient than the differential equation approach. For a charge $Z \approx 26$ and $B_{12} \approx 1$ (B_{12} is the field in units of 10^{12} gauss) an isolated atom is well described by a TF-like model, and for the same value of Z this model will remain valid for a suitable density regime. A mathematical analysis is presented, and a new equation of state is derived. (UK)

7355 ANGULAR DISTRIBUTION OF RADIO WAVES SCATTERED BY THE INTERPLANETARY MEDIUM. Matheson, D. N.; Little, L. T. (Univ. of Kent, Canterbury, Eng.). Nature (London) Phys. Sci.; 234: No. 45, 29-31(8 Nov 1971).

Some studies are described that were made in June 1971 using three interferometers in a straight line on baselines of 480, 650, and 1,130 m and at an operating frequency of 150 MHz. Observations were made using the near occultation of the Crab Nebula by the Sun, and measurements were made of decreases in fringe visibility resulting from interplanetary scattering. Strong evidence was obtained that the scattered distribution was Gaussian. Results are discussed and compared with those of other workers. (UK)

7356 RADIO SPECTRUM OF CYGNUS X-1. Hjellming, R. M. (National Radio Astronony Observatory, Green Bank, W. Va.); Wade, C. M.; Hughes, V. A.; Woodsworth, A. Nature London); 234: No. 5325, 138(19 Nov 1971).

Observations of Cyg X-1 at 2,695 and 8,085 MHz with the NRAO interferometer and at 10,630 MHz with the 150-ft antenna at Algonquin Park are reported. It is stated that, although constancy in the radio flux at 2,695 MHz has been well established, constancy has not yet been established at 8,085 and 10,630 MHz. The radio flux density is shown as a function of frequency. If no variation has occurred at any frequency it appears that Cyg X-1 has a peculiar spectrum, although this type of spectrum is common in quasars and some peculiar radio galaxies, except that the rise at higher frequencies is rather steeper. (UK)

7357 METHOD OF ALLOWING FOR KNOWN OBSERVATIONAL SELECTION IN SMALL SAMPLES APPLIED TO 3CR

QUASARS. Lynden-Bell, D. (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.). Mon. Notic. Roy. Astron. Soc.; 155: No. 1, 95-118(1971).

A useful method was developed that minimizes numerical fluctuations when deriving luminosity functions and density evolution from data subject to observational selection. The distribution of ratios of radio power to optical power for quasars was derived from the 3CR quasars; this is a steeply rising function in agreement with the observation that most quasars are radio-quiet. The density evolution of the quasi-stellar sources was derived direct from the data and a possible interpretation is an exponential decay with cosmic time. The density evolution was then used to determine the optical luminosity function of quasars. There appears to be a sharp upper limit to the optical luminosity; however, at the faint end, the luminosity function is still increasing exponentially, so that most quasar light comes from the dimmest quasars. (auth) (UK)

7358 SCATTERING OF PULSAR RADIATION IN THE INTERSTELLAR MEDIUM. Sutton, J. M. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 155: No. 1, 51-64(1971).

The scattering of pulsar radiation in the interstellar medium was investigated under the assumptions of both "strong" and "multiple" scattering, and a gaussian spatial autocorrelation function for the scattering irregularities. For a thin screen located midway between the pulsar and the observer it is shown that the frequency autocorrelation function for the resulting scintillations is the Fourier Transform of the pulse broadening function exp $(-t/\Delta t)$ arising from multipath propagation. The width of the frequency autocorrelation function to half power Δf is thus given by $2\pi \Delta f \Delta t = 1$, and this relationship is fulfilled approximately for all scattering screens. Relationships between Δf and the decorrelation frequencies used by different observers were established. Measured values of Δf and Δt showed significant deviations from the theoretical relationship $\Delta f \propto DM^{-2}$ where DM is the dispersion measure of the pulsar. These deviations can be explained by a combination of two effects—violations of the assumptions of strong and multiple scattering for nearby pulsars, and regions of anomalously strong scattering along the lines of sight to distant pulsars. (auth) (UK)

7359 SPECTROSCOPY AND PHOTOGRAPHY OF SOUTHERN-HEMISPHERE QUASAR IDENTIFICATIONS. Tritton, K. P. (Royal Greenwich Observatory, Herstmonceux, Eng.). Mon. Notic. Roy. Astron. Soc.; 155: No. 1, 1P(1971).

Spectra were obtained of a number of blue stellar objects selected from lists of suggested optical identifications of southern hemisphere radio sources, resulting in the confirmation of four quasars. Some objects from the lists were also examined using two-color (U,B) photography. Two of the four quasars confirmed spectroscopically were also examined photographically and found to have ultraviolet excesses. A fifth object also had an ultraviolet excess and was therefore probably a quasar, but proved too faint for spectroscopy. The results for these five objects are summarized, including the redshift z if measured. (auth) (UK)

7360 CONNECTION BETWEEN THE SPIRAL GALAXY NGC 4319 AND THE QUASI-STELLAR OBJECT MARKARIAN 205. Arp, Halton (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. Lett.; 9: No. 1, 1-4 (Aug 1971).

A luminous filament connects the quasi-stellar object Markarian 205 whose redshift is 0.070 with the nucleus of the spiral galaxy NGC 4319 whose redshift is 0.006. (auth)

7361 1665-MHz OH SURVEY OF THE SOUTHERN MILKY WAY. Robinson, B. J.; Caswell, J. L.; Goss, W. M. (CSIRO, Sydney). Astrophys. Lett.; 11: No. 1, 5-8(Aug 1971).

A search at 1665 MHz of 218 galactic continuum sources with $256° < l < 352°$ detected 18 new OH emission sources. Many of the new sources were observed on all four 18-cm OH transitions with both hands of circular polarization. One of the new sources (OH-330.9−0.4) is the strongest main-line emitter yet discovered, with a peak flux density of 498 flux units at 1665 MHz. In addition, the 1665-MHz search detected prominent OH absorption against 13 of the more intense continuum sources; subsequent measurements on the other 18-cm transitions show that half of these features observed in absorption at 1665 and 1667 MHz display emission on the satellite lines. (auth)

7362 OPTICAL EMISSION OF THE CRAB NEBULA PULSAR. Disney, M. J. (Australian National Univ., Canberra). Astrophys. Lett.; 9: No. 1, 9-12(Aug 1971).

A model already proposed to explain the Vela pulsar is shown to give an excellent fit to the much-more-detailed observations of NP 0532 and its surrounding nebula. (auth)

7363 COMPREHENSIVE OBSERVATIONS OF THE RAPIDLY VARYING RADIO SOURCE VRO 42.22.01 (BL LAC). Macleod, J. M.; Andrew, B. H.; Medd, W. J. (National Research Council, Ottawa). Astrophys. Lett.; 9: No. 1, 19-26(Aug 1971).

Nine outbursts have now been observed from the rapidly varying radio source VRO 42.22.01 (BL Lac). Variations in the flux density and linear polarization variations have been monitored at wavelengths of 2.8 cm and 4.5 cm at the Algonquin Radio Observatory, and at 3.75 cm at the University of Michigan Radio Observatory. In general, for the first eight outbursts, the qualitative features are consistent with the predictions of the expanding cloud model. However, some differences are noted. There is some suggestion of repetitive phenomena in the observations of the first eight outbursts. The ninth outburst is strikingly different. It contains several radio "spikes", each of amplitude one or two flux units, and duration 7 to 20 days, superimposed on the underlying outburst. (auth)

7364 PRESSURE BROADENING OF RADIO RECOMBINATION LINES. Brocklehurst, M. (University Coll., London); Leeman, S. Astrophys. Lett.; 9: No. 1, 35-6(Aug 1971).

The pressure broadening of radio recombination lines was calculated in the impact approximation. Results obtained from accurate collision cross sections, and the theory of Baranger, are in fairly close agreement with the results obtained by Griem, who used classical path approximations. (auth)

7365 BENDING OF THE SYNCHROTRON SPECTRUM AT HIGH ENERGIES. Jaffe, Jack; Treves, Aldo (Massachusetts Inst. of Tech., Cambridge). Astrophys. Lett.; 9: No. 1, 39-41(Aug 1971).

The synchrotron emission of ultrarelativistic electrons crossing a region of high magnetic field is considered. It is shown in a quite simple way that under certain conditions the resultant photon spectrum has a break in the x- or gamma-ray band. This result may be related to observations in the high-energy range of the Crab Nebula pulsar. (auth)

7366 STRUCTURE OF COMPACT EXTRAGALACTIC RADIO SOURCES. De Young, D. S. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. Lett.; 9: No. 1, 43-6(Aug 1971).

The radio spectra of 46 compact extragalactic objects were examined, and it is shown that the data are reproduced by sources which have successive uncorrelated outbursts. Models of compact sources which employ energetic particle injection into radial or multipole magnetic fields were eliminated, and it is shown that models that result in successive outbursts originating from a single object have difficulty reproducing the observed time scale between outbursts. It is noted that models that employ multiple events occurring in physically separate regions are consistent with the spectral data. (auth)

7367 IDENTIFICATION OF THE RYLE–NEVILLE RADIO SOURCES. Penston, M. V. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J.; 170: No. 3, 395-9(15 Dec 1971).

A complete search for optical identifications of the Ryle–Neville (1962) radio survey was performed. A particularly interesting identification was that of RN 8 = 3C 61.1 with a star with an ultraviolet excess in a small cluster of galaxies. The complete identification of this catalog gives constraints to the cosmological model and the optical and radio luminosity functions of QSOs and radio galaxies. (auth)

7368 POLARIZATION OF RADIO SOURCES. III. ABSORPTION EFFECTS ON CIRCULAR POLARIZATION IN A SYNCHROTRON SOURCE. Pacholczyk, A. G.; Swihart, T. L. (Univ. of Arizona, Tucson). Astrophys. J.; 170: No. 3, 405-8(15 Dec 1971).

The transfer problem for polarized radiation is solved for a uniform synchrotron source. The absolute value of the degree of circular polarization V/I has the same dependence on frequency and magnetic field in the two extremes of very large and very small optical thickness of the source. It is remarkable that V reverses sign at an intermediate optical thickness of the source. (auth)

7369 NONTHERMAL OH EMISSION IN INTERSTELLAR DUST CLOUDS. Turner, B. E. (National Radio Astronomy Observatory, Green Bank, W. Va.); Heiles, Carl. Astrophys. J.; 170: No. 3, 453-62(15 Dec 1971).

Satellite-line emission from OH molecules was detected for the first time in dust clouds. Although the main lines had strengths characteristic of LTE, the satellite lines did not. The 1720-MHz transition was anomalously strong compared with the main-line emission, while the 1612-MHz transition was anomalously weak. This situation applied to all three positions so far observed in two different clouds. The anomalies are qualitatively of the type that can be explained by near- or far-infrared pumping of OH. The ratio of main lines, not perturbed on this theory, was used to derive column densities and excitation temperatures. These conditions were used to apply the near- and far-infrared theory, for which quantitative agreement with the observed satellite-line anomalies seems possible in the future. (auth)

7370 COHERENT SYNCHROTRON RADIATION. Goldreich, Peter (California Inst. of Tech., Pasadena); Keeley, D. A. Astrophys. J.; 170: No. 3, 463-77(15 Dec 1971).

A simple model consisting of a distribution of charges constrained to move on a ring was the basis of an investigation of coherent synchrotron radiation. The radiation produced as a result of a nonrandom particle distribution on the ring was examined from the viewpoint of the interaction of individual particles with the total electric field of the system. A linear stability analysis showed that, under reasonable conditions, a uniform distribution of particles is unstable to clumping. The model was applied to pulsars, in which the high brightness temperatures suggest that a cooperative emission mechanism is responsible for the radiofrequency radiation. The application to circular accelerators and storage rings is discussed briefly. (auth)

7371 PROPERTIES OF HADRON MATTER. II. DENSE BARYON MATTER AND NEUTRON STARS. Leung, Y. C. (Southeastern Massachusetts Univ., North Dartmouth); Wang, C. G. Astrophys. J.; 170: No. 3, 499-521(15 Dec 1971).

Certain details are provided of a nuclear-matter computation, based on the Brueckner–Bethe–Goldstone theory of nuclear reaction, which leads to an equation of state for matter in the density region 10^{13} to 5×10^{14} g cm^{-3}. The possibilities are explored that at very high baryon densities ($>10^{17}$ g cm^{-3}) or for very short baryon separations (<0.1 fm), the net baryon–baryon interaction may be negligible so that the results of dynamical models, like the statistical bootstrap model and the dual-resonance model, may be applicable to the study of dense baryon matter. Several plausible equations of state are constructed, and their effect on the limiting mass of the neutron star is examined. (auth)

7372 FURTHER RADIO OBSERVATIONS OF SCORPIUS X-1. Wade, C. M.; Hjellming (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J.; 170: No. 3, 523-8(15 Dec 1971).

Continuing interferometric observations of Sco X-1 at 2695 and 8085 MHz have provided more complete data on its structure and variability. To date, nearly 300 hours of observation have shown that major flaring activity is in progress about one-sixth of the time. The triple structure of the source is a persistent feature, but the position of one component may have changed somewhat during the past year. (auth)

7373 PLASMA RADIATION FROM COLLISIONLESS MHD SCHOCK WAVES. I. SHOCK-REGION ANALYSIS. Smith, D. F. (National Center for Atmospheric Research, Boulder, Colo.). Astrophys. J.; 170: No. 3, 559-71(15 Dec 1971).

The structures of perpendicular collisionless magnetohydrodynamic shock waves in which the magnetic pressure is much larger than the particle pressure and charge neutrality applies were examined as potential sources of electron plasma waves. It is shown that significant excitation of such waves cannot occur in shocks with a laminar solution, due to their extreme velocity inhomogeneity. Turbulent shocks are characterized by a highly nonthermal energy density in ion-acoustic waves which effectively suppress any instability of electron plasma waves and preferentially heat the electrons. The plane of the shock wave is allowed to form a slight angle with respect to the direction of the ambient magnetic field. This allows only the fast electrons from the tail of the Maxwellian distribution in the shock to escape forward and acts as a selection mechanism for the formation of a beam. The distribution function of the escaping electrons relevant for the production of plasma waves is calculated, by taking into account the density and magnetic field gradients and scattering by ion-acoustic waves in the shock. (auth)

7374 DENSITY-SIZE RELATION OF HII REGIONS. Kodaira, Keiichi (Tokyo Univ.). Publ. Astron. Soc. Jap.; 22: No. 2, 157-63(1970).

A morphological study of H II regions was extended over a wide range of the emission measure, $\epsilon = 10^3$ to 10^8 cm^{-6} pC, by including recent radio data. A statistical relation $N_e l^{1/2} \simeq$ constant was found between the root-mean-square electron density, N_6, and the representative size l of H II regions. The log N_6–log l diagram was interpreted as the evolutionary track of expanding H II clouds during the near-main-sequence stage of the exciting OB stars. (auth)

7375 STUDY OF SIMULTANEOUS OPTICAL AND X-RAY OBSERVATIONS OF SCORPIUS X-1. Pelling, Ray Michael. San Diego, Calif.; Univ. of California (1971). 82p. University Microfilms Order No. 71-27,900.

Thesis.

The x-ray telescope carried on board OSO-III provided observations of the celestial x-ray source Sco X-1 in the energy range 7.7 to 22 keV during the period extending from May 19 to June 13, 1967. Instrument response and sensitivity between these dates allowed measurement of the source flux in the 7.7- to 12.5-keV energy channel at a 10 to 20% confidence level for each of about ten two-minute integration periods available during a typical 90-minute orbital period. Simultaneous optical observations available during portions of x-ray coverage allowed determination of correlational properties of the x-ray and optical emissions for both the flaring and quiescent optical states. (TSS) (Diss. Abstr. Int., B)

7376 RADIO OUTBURSTS IN QUASARS AND NUCLEI OF SEYFERT GALAXIES. Takarada, Katsuo (Nagoya Univ., Japan). Publ. Astron. Soc. Jap.; 22: No. 4, 551-8(1970).

On the basis of the expanding-source model, by which radio outbursts observed in some quasars and in some nuclei of Seyfert galaxies are qualitatively well explained, the relations between maximum flux densities of two components whose states of polarization are perpendicular to each other were derived, along with the relations between the critical frequencies at which the flux densities of both components reach their respective maxima. From these relations, the expression for the expansion velocity was obtained. These relations, together with a sufficient amount of observational data, will play a decisive role in the verification of the expanding-source model. (auth)

7377 ATMOSPHERIC ATTENUATION AND SCINTILLATION OF MICROWAVES FROM OUTER SPACE. Yokoi, Hiroshi; Yamada, Matsuichi; Satoh, Toshio (Kokusai Denshin Denwa Co., Ltd., Tokyo). Publ. Astron. Soc. Jap.; 22: No. 4, 511-24(1970).

Atmospheric attenuation and scintillation of radio waves from outer space were analyzed theoretically. The result was compared with the observations of the Moon and Cas A using the 22 m antenna of KDD. Absorptive attenuation measured at 4 and 6 GHz agreed well with the calculated values based on the absorption coefficient and equivalent atmospheric thickness in the CCIR report. Refractive attenuation was derived from the differential coefficient of the refracted angle. Diffusive attenuation depends on the turbulence of atmosphere and increases with increasing antenna aperture; it is proportional to the equivalent path length and to the square of frequency. Scintillation decreases with increasing aperture and is proportional to the 1.5th power of the equivalent path length. (auth)

7378 MODULATION IN LONG SCALE TIME VARIATIONS OF QUASI-STELLAR RADIO SOURCES AND SEYFERT GALAXIES DUE TO INTERGALACTIC SCINTILLATIONS. Yoshioka, Shigeru (Nagoya Univ., Japan). Publ. Astron. Soc. Jap.; 22: No. 4, 423-8(1970).

Small intensity fluctuations superposed on the smooth increase and decrease of the radio flux of radio outbursts in quasi-stellar radio sources with a time scale of the order of a year in the decimeter-wavelength region are partially interpreted in terms of intergalactic scintillations. If this interpretation is accepted, the angular source size of radio outbursts in a quasi-stellar radio source should be nearly equal to or smaller than 0.00002″ at the early stage of the outburst. (auth)

7379 H I ABSORPTION MEASUREMENTS ON TWO GALACTIC REGIONS CONTAINING SUPERNOVA REMNANTS AND H II REGIONS. Kazes, I. (Observatoire, Meudon, France). Astron. Astrophys.; 15: No. 3, 460-7(Dec 1971).

Through H I absorption measurements, distances were estimated for three supernova remnants and their nearby H II regions. No evident physical association exists between these two kinds of galactic objects. However, G348.8 – 0.6, an H II region, and G350.0 – 0.3, presumably a thermal radio source, were found to be related. (auth)

7380 IMPORTANCE OF PULSAR OBSERVATIONS FOR PLANETARY PHYSICS. Treves, A. (Massachusetts Inst. of Tech., Cambridge). Astron. Astrophys.; 15: No. 3, 471-3 (Dec 1971).

The possibility of observing planetary systems of pulsars is examined. The expected perturbation in the time of arrival of pulses is computed and the detectability is discussed. (auth)

7381 MEASUREMENT OF THE PRIMARY X-RAY DIFFUSE COMPONENT IN THE RANGE FROM 25 TO 200 keV. Horstman-Moretti, E.; Fuligni, F.; Brini, D. (CNR, Bologna). Nuovo Cim.; 6B: No. 1, 68-82(11 Nov 1971).

An apparatus for the measurement of x rays from 25 to 200 keV was flown aboard a rocket. A screened detector was included to evaluate the instrumental background. A wide scan of the sky was performed and a spectrum of the primary diffuse component was obtained, which is best fitted by a power law $35E^{-1.95\pm0.1}$. Regions near sources were excluded in this analysis. The detectors also looked toward the Earth and a rough spectrum of the Earth albedo is shown. (auth)

7382 ENERGY RELEASE FROM COLLIDING BLACK HOLES. Ross, D. K. (Iowa State Univ., Ames). Nuovo Cim.; 6B: No. 1, 83-7(11 Nov 1971).

Using general principles, the amount of mass—energy that can be extracted from two extreme Kerr rotating black holes when they collide is found to be, at most, 21% of their total initial mass—energy. The maximum efficiency of energy extraction obtains for a reversible collision of two black holes of equal irreducible mass in which the individual angular-momentum vectors are parallel. (auth)

7383 ROCKET MEASUREMENTS OF COSMIC RADIO NOISE BETWEEN 1.16 AND 2.40 MHz AT 1600 km ALTITUDE. Hoang, S. (Observatoire, Meudon, France). Astron. Astrophys.; 15: No. 3, 383-402(Dec 1971).

A rocket cosmic-radio-noise experiment is described in which two crossed 36-m dipole antennas were each connected to receivers through separate input circuits tuned by servo loops to obtain a high sensitivity for the overall system. The variation of the noise level with altitude was found to be consistent with the theory of the electromagnetic radiation resistance and the electron density distribution derived from the Alouette II topside sounder. The extraordinary mode disappeared produced a drop in the noise level that was observed at three frequencies and used to check the electron density distribution. Spin modulation of the signal was observed and can be explained in terms of nonuniform sky brightness distribution and anisotropy of the medium. The measured antenna impedance and the calculated electromagnetic radiation resistance were used to interpret the cosmic-noise data obtained near apogee at 1636 km altitude in the direction $l = 172°$, $b = 36°$. The following intensities were deduced at 2.40, 1.65, 1.61, and 1.16 MHz respectively: 4.2 ± 16%, 3.3 ± 24%, 3.2 ± 24%, and $3.9 \pm 24\% \times 10^{-20}$ W m^{-2} Hz^{-1} $sterad^{-1}$. These results confirm the flatness of the cosmic noise spectrum around 2 to 3 MHz, but they are higher than most of the previously published results; reasons for this are discussed. (auth)

7384 CORRELATION OF NEUTRAL HYDROGEN AND RADIO CONTINUUM LOOP IV. Fejes, I. (Kapteyn Astronomical Lab., Groningen, Netherlands. Netherlands Foundation for Radio Astronomy, Groningen). Astron. Astrophys.; 15: No. 3, 419-23(Dec 1971).

A low-velocity neutral-hydrogen spur is found to coincide with the radiocontinuum Loop IV at galactic latitudes above $b = +40°$. The neutral-hydrogen spur follows Loop IV within 2.5° along an arc of 180°. The average excess surface density of the neutral-hydrogen in the spur is 3×10^{19} atoms/cm^2. The mass associated with it is about 150 $M_\odot$ if the distance is 100 pc. (auth)

7385 HEATING OF GAS NEAR QUASARS, SEYFERT-GALAXY NUCLEI, AND PULSARS BY LOW-FREQUENCY RADIATION. Levich, E. V.; Syunyaev, R. A. (Inst. of Chemical Physics, Moscow. Inst. of Applied Mathematics, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 3, 363-70(Nov-Dec 1971).

Translated from Astron. Zh.; 48: No. 3, 461-71(May-Jun 1971).

The heating and cooling of thermal electrons by low-frequency radiation due to the induced Compton effect and free—free processes exerts an influence on the thermal balance of the gas surrounding strong, compact radio and infrared sources such as quasars, pulsars, and Seyfert-galaxy nuclei. Relativistic plasma may exist in the immediate neighborhood of these sources. (auth)

7386 INCOMPATIBILITY OF THE BRIGHTNESS FLUCTUATIONS OF THE QUASAR 3C 273 WITH THE MODEL OF RANDOM INDEPENDENT PULSES. Gudzenko, L. I.; Ozernoi, L. M.; Chertoprud, V. E. (Lebedev Inst. of Physics, Moscow. Astronomical Council, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 3, 371-6(Nov-Dec 1971).

Translated from Astron. Zh.; 48: No. 3, 472-8(May-Jun 1971).

Terrell and Olsen's arguments [Astrophys. J., 161: 399(1970)] for independent, randomly occurring pulses as a model for the optical variability of the quasar 3C 273 were subjected to a critical examination. Their model is shown to be implausible both from a physical viewpoint and in terms of mathematical statistics. Of the two simplest alternative models for the optical variability of 3C 273, a single source or an aggregate of independent sources experiencing random outbursts, the second appears improbable. (auth)

7387 LINEAR POLARIZATION OF THE PULSAR PSR 2218 + 47. Shitov, Yu. P. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 3, 501-2(Nov-Dec 1971).

Translated from Astron. Zh.; 48: No. 3, 638-40(May-Jun 1971).

Radio pulses from the pulsar PSR 2218 + 47 were found to be linearly polarized; the degree of linear polarization was $P \geq 75\%$. The longitudinal component of the interstellar magnetic field was determined from Faraday rotation to be equal to 9.5×10^{-7} G. (auth)

7388 IDENTIFICATION AND PHOTOMETRY OF 3CR RADIO SOURCES. II. THE SOURCE 3C 173. Wlerick, G.; Lelievre, G. (Observatoire de Paris, Meudon, France). Astron. Astrophys.; 16: No. 1, 53-7(Jan 1972). (In French).

The source 3C 173 was studied in the UBV photometric system on plates taken with the electron camera. This very faint source $(20 \leqq B < 22)$ has the characteristic properties of a quasar, including a strong uv excess. It belongs to a family of QSS that are radio-stable and optically strongly variable. It is noted also that, between March and November 1970, the V magnitude changed only slightly, while the B – V color index greatly increased: $\Delta(B - V) > 0.7$; this suggests an important change in the structure of the optical spectrum. (auth)

7389 COMMENTS ON A PAPER BY K. ROHLFS. Burton, W. B. Astron. Astrophys.; 16: No. 1, 158-62(1 Jan 1972).

Rohlfs' (Astr. Astrophys. 12, 43(1971)) two-compartment model of interstellar neutral hydrogen gas is discussed and reservations are noted. A reply by Rohlfs is included. (W.D.M.)

7390 X-RAY AND GAMMA-RAY ASTRONOMY. Fazio, G. G. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.). pp 72-100 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. I. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.1).

A review of the studies in the new fields of x- and gamma-ray astronomy is presented. The cosmic electromagnetic spectrum exhibits a monotonic decline in intensity per unit frequency as a function of frequency. It is shown that x rays (about 1 keV) disclose the first important results in high-energy astronomy. (IAA)

7391 PRECISE LOCATION OF CELESTIAL X-RAY SOURCES. Rappaport, Saul (Massachusetts Inst. of Tech., Cambridge). pp 101-5 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. I. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.1).

A new technique for the precise location of celestial x-ray sources, using the rotating modulation collimator, is described. Sounding rockets launched from White Sands Missile Range were used for the detection and location of GX3 + 1, GX5 – 1, GX9 + 1, and GX17 + 2. The lack of radio emission from these x-ray sources indicates that these four are quite different from the supernova remnants and may be more like the source Sco x – 1. A scan of the Virgo clusters reveals the emission of x rays from M87 to be about 10^6 times the x-ray luminosity of any known galactic x-ray source. (J.C.W.)

Solar Phenomena

Refer also to abstracts 7573 and 7594.

7392 REGULAR PULSES FROM THE SUN AND A POSSIBLE CLUE TO THE ORIGIN OF SOLAR COSMIC RAYS. McLean,

D. J.; Sheridan, K. V.; Stewart, R. T.; Wild, J. P. (CSIRO, Sydney). Nature (London); 234: No. 5325, 140-2(19 Nov 1971).

It is stated that a curious rare feature of the metre-wave continuum radiation received from some large solar flares is a pulsating structure that modulates the intensity in a periodic or quasi-periodic manner. This modulation may persist for about a minute, and the pulsation period is of the order of a second. Of various explanations suggested the most satisfactory is considered to be that in which the radiation is attributed to synchrotron radiation emitted by electrons in a magnetic flux tube embedded in the solar corona and the pulsations are attributed to modulation by standing MHD waves set up within the tube. Further evidence of this phenomenon is presented, together with a model that accounts both for the acceleration of the emitting electrons and for the pulsations. There is also evidence to suggest that energetic protons may be accelerated by the same process, and it is considered that the phenomenon affords a possible observational clue to a physical process by which solar cosmic rays can be generated high in the solar corona. The studies described were stimulated by an unusual pulsating event recorded with the Culgoora radiospectrograph on Sept. 27, 1969, when a remarkably regular series of about 50 sharp pulses was received in the frequency range 100 to 200 MHz, each pulse occurring almost simultaneously throughout the frequency range. The pulses began about 25 min after the start of a large flare. A search through the records revealed seven other instances of pulsations. (UK)

7393 EXTREME-ULTRAVIOLET FLASHES OF SOLAR FLARES OBSERVED VIA SUDDEN FREQUENCY DEVIATIONS: EXPERIMENTAL RESULTS. Donnelly, Richard F. (Environmental Research Labs., Boulder, Colo.). Solar Phys.; 20: No. 1, 188-203(Oct 1971).

Properties of solar-flare euv flashes measured via a type of ionospheric event, called a sudden frequency deviation (SFD), are presented. SFD's are sensitive to bursts of radiation in the 1- to 1030-Å wavelength range. He II 303.8 Å, O V 629.7 Å, H Lγ 972.5 Å, and C III 977.0 Å have essentially the same impulsive time dependence as the 1 to 1030 Å flash responsible for SFD's. Soft x rays (2 to 20 Å) and certain euv lines have a much slower time dependence than the 1 to 1030 Å flash. Most SFD's have some fine structure, but marked quasi-periodicity in euv flashes is quite rare; euv flashes are closely associated with hard x-ray bursts, white-light emission, microwave radio bursts, and small bright impulsive kernels in the Hα flare. The intensity of euv flashes depends on the central meridian distance of the Hα flare location; the intensity decreases at the limb. The total energy radiated in the 10- to 1030-Å flash for the largest events observed is about 10^{31} ergs. (auth)

7394 INHOMOGENEITIES IN THE SOLAR ATMOSPHERE FROM THE Ca II INFRARED LINES. Mein, Pierre (Observatoire de Paris, Meudon, France). Solar Phys.; 20: No. 1, 3-18 (Oct 1971).

From a time sequence of high-dispersion spectra taken by Evans, the solar fine structures were studied in the Ca II infrared triplet. The Doppler shifts and the intensity fluctuations in different points of the profiles were converted into fluctuations of the model atmosphere. A weighting function method was worked out in that purpose. The theoretical line profiles were computed in non LTE from a program written by Dumont. The results were arranged in two parts: (1) Low temporal frequencies. A three-column model describes the steady field of temperature, microturbulence, and radial velocities fluctuations in the photosphere–chromosphere transition zone. (2) Oscillations. The propagation of waves was considered in the three above-mentioned columns. The oscillation amplitudes seemed statistically larger in the hot column. The vertical phase velocity was very large, even for frequencies higher than the cut-off frequency of acoustic waves. Velocity and temperature fluctuations were connected by different curves of phase lags and amplitude ratios suggesting a short relaxation time of the temperature fluctuations in the low chromosphere. (auth)

7395 USING CN λ 3883 SPECTROHELIOGRAMS TO MAP WEAK PHOTOSPHERIC MAGNETIC FIELDS. Sheeley, N. R. Jr. (Kitt Peak National Observatory, Tucson, Ariz.). Solar Phys.; 20: No. 1, 19-25(Oct 1971).

By photographically averaging time sequences of high-resolution CN λ3883 spectroheliograms, the noise level due to the rapidly fluctuating intensity of the solar background was reduced significantly. Very faint faculae that are lost in the noise on a single frame are easily visible on such an enhanced picture. A comparison between these enhanced spectroheliograms and a photoelectric magnetogram suggested that the brightness–magnetic field correlation extends to much weaker field strengths and fainter faculae than can be detected on a single, high quality CN λ3883 spectroheliogram. (auth)

7396 TEST OF A SOLAR STREAMLINE ANALYSIS ON TERRESTRIAL WIND DATA. Fischer, Hans J. E. (Massachusetts Inst. of Tech., Cambridge). Solar Phys.; 20: No. 1, 26-30(Oct 1971).

Terrestrial wind data were used to test a technique for obtaining solar streamline patterns from line-of-sight velocity measurements. The method of analysis and its limitations are discussed. The major features of the reconstructed terrestrial streamline pattern agree satisfactorily with those of the actual wind field. (auth)

7397 SPECTRAL INVESTIGATION OF CHROMOSPHERIC FINE STRUCTURE. Grossmann-Doerth, Ulrich; von Uexkuell, Marina (Fraunhofer Institut, Freiburg i. B.). Solar Phys.; 20: No. 1, 31-46(Oct 1971).

Hα spectra and effectively simultaneous filtergrams were taken at the Fraunhofer Observatory on Capri with the 35-cm domeless Coudé. The spatial resolution of the 19 best spectra selected for analysis was estimated to be 1 to 2 arc sec. The comparison of several hundred Hα line profiles emitted by typical chromospheric structure elements with theoretical prediction yielded strong evidence to suggest that the chromosphere consists of two parts: a lower, rather uniform layer at rest superposed by "clouds" (condensations of great spatial variability) that constitute the well-known structure pattern of Hα filtergrams. For most image points the line-of-sight velocity, optical thickness, source function, and Doppler broadening of these clouds could be determined. While the values of the latter three quantities were found to be similar to what Beckers (1968) found for limb spicules, the velocities of the bright and dark mottles were considerably smaller than to be expected if these features were the spicules as seen on the disk. However, the results do not rule out the possibility that the spicules rise at the centers of rosettes where they are difficult to detect. (auth)

7398 STUDY OF THE FINE STRUCTURE OF THE SOLAR CHROMOSPHERE AT THE LIMB. Alissandrakis, C. E.; Macris, C. J. (Research Center for Astronomy and Applied Mathematics, Athens). Solar Phys.; 20: No. 1, 47-56(Oct 1971).

The dimensions, distances from the inner limb, and lifetimes of bright mottles at the limb were measured. Spicule lifetimes were also measured. The problem of the "dark band", lying just above the inner limb, as well as the relations between bright mottles and spicules are discussed. (auth)

7399 STRUCTURE OF SOLAR FACULAE. Krat, V. A.; Stoyanova, M. N. (Pulkovo Observatory, Leningrad). Solar Phys.; 20: No. 1, 57-8(Oct 1971).

Recently Suemoto (1963) and Pasachoff (1970) proposed a model of calcium faculae (H_2, K_2 lines of Ca II) consisting of two streams of matter moving in opposite directions. Effects and special features seen on many of the Pulkovo spectrograms are discussed. (W.D.M.)

7400 Lα MEASUREMENTS DURING THE SOLAR ECLIPSE OF NOVEMBER 12, 1966. Weeks, L. H. (Air Force Cambridge Research Labs., Bedford, Mass.); Smith, L. G. Solar Phys.; 20: No. 1, 59-63(Oct 1971).

Rocket measurements of the solar Lα (1216 Å) flux during various phases of the total eclipse of November 12, 1966 confirm that the radiation emanates from the chromosphere. A significant difference between two portions of the photosphere limb is attributed to enhanced emission in the region of a Ca K plage. The average size of the Lα disk is found to be approximately 4000 km above the photosphere, and a brightening is observed at the limb. (auth)

7401 TOPOLOGY OF FORCE-FREE MAGNETIC FIELD NEAR BIPOLAR SUNSPOTS. Raadu, M. A.; Nakagawa, Y. (National Center for Atmospheric Research, Boulder, Colo.). Solar Phys.; 20: No. 1, 64-77(Oct 1971).

The topological character of a new type of solution representing a force-free magnetic field near bipolar sunspots was examined. It is shown that some of the observed topological features of chromospheric fibrils and filaments in Hα can be interpreted in terms of the configuration of the magnetic lines of force of the present solution. In particular, by the examples considered, the observed twisted S-shape topology of lower-lying fibrils and the orientation of prominences (higher filaments) associated with sunspots are successfully reproduced. (auth)

7402 PROMINENT ZEEMAN LINES IN SUNSPOT SPECTRA AND THEIR TEMPERATURE SENSITIVITY. Wittmann, A.

(Univ., Goettingen, Ger.). Solar Phys.; 20: No. 1, 78-80(Oct 1971).

Increasing attention has been drawn recently to the fact that the strong temperature sensitivity of the frequently used Zeeman triplet at 5250.2 Å leads to considerable errors of magnetograph measurements. A survey of Zeeman lines was made, including more complicated multiplets, with the aim of selecting the most suitable lines. (W.D.M.)

7403 EUV AND SOFT X-RAY IMAGES OF THE SUN ON MARCH 11, 1971. **Braeuninger, H.; Einighammer, H. J.; Feitzinger, J. V.; (and others) (Univ., Tuebingen, Ger.). Solar Phys.; 20: No. 1, 81-4(Oct 1971).**

At the time of exposure the solar activity was at a low level. The x-ray photographs showed at least three bright emission areas on the dark disc and an intense equatorial brightening on the limb at all the observed wavelengths. On the brightened eastern limb some brilliant, well-distinguishable emission centers could be separated. By comparison of the Hα spectroheliogram with the x-ray photos it was obvious that the soft x-ray emitting regions on the disc could be spatially associated with the Hα plages. (W.D.M.)

7404 GYRORESONANCE ABSORPTION OF PLASMA WAVES IN THE CORONA AND THE FINE STRUCTURE OF SOLAR RADIO BURSTS. **Zheleznyakov, V. V.; Zlotnik, E. Ya. (Scientific Research Radiophysical Inst., Gorky, USSR). Solar Phys.; 20: No. 1, 85-94(Oct 1971).**

The important part played by plasma wave absorption at the higher harmonics of the electron gyrofrequency (under conditions of the so-called double plasma resonance) in the solar corona is considered. An explanation is proposed for the fine structure of Type III bursts on the basis of this effect. (auth)

7405 PULSATING REGIME OF STREAM INSTABILITY AND ORIGIN OF RAIN-TYPE RADIO BURSTS. **Zaitsev, V. V. (Scientific Research Radiophysical Inst., Gorky, USSR). Solar Phys.; 20: No. 1, 95-105(Oct 1971).**

An interpretation of "rain" type radio bursts is suggested on the basis of a pulsating regime of the stream instability. This regime may occur in ejected stabilized ion streams trapped in the region in which the magnetic field of the corona has a typical bipolar structure. (auth)

7406 U-TYPE SOLAR RADIO BURST ORIGINATING IN THE OUTER CORONA. **Stone, R. G.; Fainberg, Joseph (Goddard Space Flight Center, Greenbelt, Md.). Solar Phys.; 20: No. 1, 106-11(Oct 1971).**

The observation of a U-type solar radio burst with a reversing frequency of approximately 0.7 MHz suggests the presence of a magnetic bottle extending out to about 35 $R_{\odot}$. A possible model of this loop structure is developed from the data. The occurrence of low-frequency U-bursts seems to be extremely rare although magnetic bottles may develop frequently during solar maximum. (auth)

7407 SPECTRAL FEATURES OF LARGE TYPE-IV BURSTS AND INTERRELATION TO SOLAR-TERRESTRIAL PHENOMENA. **Akinyan, S. T. (IZMIRAN, Moscow); Mogilevskii, E. I.; Boehme, A.; Krueger, A. Solar Phys.; 20: No. 1, 112-21(Oct 1971).**

The Type IV burst phenomenon consists of at least five physically distinct components or phases. Concerning the spectral and polarization characteristics of the radio emission, the x-ray emission, and the association of energetic-particle emission, two main classes of Type IV burst components can be distinguished. The first class associated with energetic-particle events comprises the (especially hard) x-ray burst, the Type IVμ and mA_1 components. With respect to the dynamics of the burst source, a "quasi-stationary" mA_1 phase can be distinguished from a "moving" mA_2 phase. The general tendencies of the development of large Type IV events are discussed with regard to the possibility of the occurrence of neutral points of the magnetic field in greater coronal heights. (auth)

7408 RADIO OBSERVATIONS OF FILAMENTS DURING THE ECLIPSES OF SEPTEMBER 11, 1969 AND MARCH 7, 1970. **Simon, M.; Wickstroem, Bengt-Arne (State Univ. of New York, Stony Brook). Solar Phys.; 20: No. 1, 122-9(Oct 1971).**

By high-resolution observations at 3-mm wavelength during the eclipses of September 11, 1969 and March 7, 1970, two filaments were observed on the solar disc in absorption. The 3.3-mm eclipse data and 9.5-mm (non-eclipse) data pertaining to the large filament observed on September 11, 1969 were analyzed in detail. At 3.3 mm the plasma temperature in the filament was about 3900 K, and at 9.5 mm it was about 6400 K, indicating a multicomponent model. An upper bound of $N_e^2L < 10^{28}$ for the emission measure of a hot component at $T > 10^4$K was obtained. (auth)

7409 POLARIZATION OF SOLAR-MICROWAVE BURSTS OBSERVED AT 17 GHz. **Wassenberg, Werner (Max-Planck-Institut fuer Radioastronomie, Bonn). Solar Phys.; 20: No. 1, 130-5(Oct 1971).**

The polarization distribution of 17-GHz bursts observed within a period of 1 yr after maximum solar activity was studied. The typical variation of polarization with time of impulsive bursts lead to the conclusion of a thermalization of the emission region in the post-burst phase. The fine structure of the polarization curve of complex bursts is shown and two possible interpretations of the observed inversion of the polarization at 17 GHz during a complex event are given. (auth)

7410 19-GHz(1.58cm) SOLAR RADIO BURSTS IN THE PERIOD JULY 1967 TO DECEMBER 1969. **Croom, D. L.; Powell, R. J. (Radio and Space Research Station, Slough, Eng.). Solar Phys.; 20: No. 1, 136-46(Oct 1971).**

The results of 2.5-yr (July 1967—December 1969) monitoring of solar radio bursts at 19 GHz ($\lambda = 1.58$ cm) at the Radio and Space Research Station, Slough, are presented. Observations at this frequency are important in helping to define the form of the microwave spectrum of solar bursts since many of the more intense bursts have their spectral peak in the frequency region above 10 GHz. Fifteen bursts with peak flux increases exceeding 1000×10^{-22} Wm^{-2} Hz^{-1} were observed during this period. (auth)

7411 NOTE ON THE ACCELERATION PHASE OF HIGH-ENERGY PARTICLES IN THE SOLAR FLARE ON JULY 7, 1966. **Sakurai, Kunitomo (Goddard Space Flight Center, Greenbelt, Md.). Solar Phys.; 20: No. 1, 147-9(Oct 1971).**

A solar proton flare of importance 2B occurred at 0023 UT on July 7, 1966. The position of this flare was 34° north and 45° west on the solar disk. Since this flare occurred during the observing period of PFP, many refined observational data are available on optical, radio, x-ray, and particle events. By using these data, especially on radio burst data, a study was made on the acceleration phase of solar cosmic rays and relativistic electrons and on the generating process of hydromagnetic shock waves which excited a Type II radio burst detected below about 100 MHz. (auth)

7412 PROPAGATION OF LOW-ENERGY PROTONS ASSOCIATED WITH THE JANUARY 24, 1969 SOLAR FLARE. **Balogh, A.; Hedgecock, P. C.; Hynds, R. J.; Sear, J. (Imperial Coll. of Science and Tech., London). Solar Phys.; 20: No. 1, 150-65 (Oct 1971).**

Directional low-energy solar proton measurements together with interplanetary magnetic field measurements are presented. Propagation of 1- to 13-MeV solar protons is discussed in terms of the relative importance of field-aligned streaming compared to convection of the proton population in the solar wind. Evidence is presented to show that protons associated with the January 24, 1969 solar flare were stored near the Sun for at least 90 minutes. It is also shown that under favorable conditions solar protons can be accelerated near the Earth's bow shock. The decay of solar protons is shown to be mainly convective; however, there are indications that in smooth field regimes convection of 1-MeV solar protons can be greatly reduced. Finally, it is pointed out that the effect of adiabatic deceleration can be quite important. (auth)

7413 PROPAGATION OF SOLAR COSMIC-RAY BURSTS. **Ng, C. K.; Gleeson, L. J. (Monash Univ., Clayton, Australia). Solar Phys.; 20: No. 1, 166-85(Oct 1971).**

A model is presented in which is shown the three phases of anisotropy that occur during solar cosmic-ray events observed in the 7.5- to 21-MeV kinetic-energy interval and reported by McCracken et al. (1971): (i) a highly anisotropic, near field-aligned, initial phase, (ii) a convective phase, and (iii) a late-time phase in which the anisotropy is approximately perpendicular to the mean interplanetary magnetic field. The model is based on the cosmic-ray particles being convectively transported out from the Sun, undergoing anisotropic diffusion along the interplanetary magnetic-field lines, and losing energy by adiabatic deceleration or by collision processes. The event is seen simply as a pulse moving outward from the Sun after a cosmic-ray burst with a negative density-gradient in front of it and a positive gradient behind. The convective phase (ii) occurs as the spatial peak moves past the observer and has a propagation speed V_d associated with it; the anisotropy vector late in the decay phase (iii) is the result of a residual "balance" between the radial outward convection and the inward radial component of the anisotropic diffusion. The mathematical solutions are based upon a diffusion coefficient proportional to heliocentric radius and independent of energy and are thus rather special. However, they yield formulae for the propagation speed of the convective phase and the direction in space of the long-time anisotropy, which are useful as a guide to the dependence of these quantities on the solar wind speed V, the diffusion coefficient κ and the spectral index μ. In this model V_d increases with V, κ, and μ; and θ', the angle between the anisotropy vector at infinite time and the outward radial direction increases with κ/V and decreases as μ is increased. These predictions of the dependence of θ and′ V_d upon V, κ, and μ are open to observational verification. (auth)

7414 EXTREME-ULTRAVIOLET RADIATION FROM SOLAR FLARES. Bhatia, V. B.; Tandon, J. N. (Univ. of Delhi). Astrophys. Lett.; 9: No. 1, 13-15(Aug 1971).

To explain the similarity between the time structure of the extreme-ultraviolet flashes from solar flares and the hard x rays it is suggested that the extreme-ultraviolet radiation is produced by the synchrotron emission of the same electrons that are responsible for hard x rays. The flux of extreme-ultraviolet radiation is calculated and compared with observations. (auth)

7415 IRON-LINE EMISSION DURING SOLAR FLARES. Doschek, G. A.; Meekins, J. F.; Kreplin, R. W.; Chubb, T. A.; Friedman, H. (Naval Research Lab., Washington, D. C.). Astrophys. J.; 170: No. 3, 573-86(15 Dec 1971).

Iron-line emission ~1.9 Å recorded by NRL Bragg crystal spectrometers on OSO-6 during intense solar soft x-ray flares is discussed. Individual emission features are resolved in second order, and variability in emission from Fe XXV relative to inner-shell emission from lower ionization stages is considered. A feature at 1.932 Å is attributed to radiation from Fe II in the photosphere. In the region of the second-order iron spectra, the two fine-structure components of the first excited ^2P state of hydrogenic argon are resolved. (auth)

7416 UPPER LIMIT ON THE HARDNESS OF THE NONTHERMAL ELECTRON SPECTRA PRODUCED DURING THE FLASH PHASE OF SOLAR FLARES. Kane, S. R. (Univ. of California, Berkeley). Astrophys. J.; 170: No. 3, 587-91(15 Dec 1971).

The observations of impulsive solar-flare x rays $\gtrsim$10 keV made with the OGO-5 satellite were analyzed in order to study the variation of the nonthermal electron spectrum from one flare to another. The x-ray spectrum at the maxima of 129 impulsive x-ray bursts is represented by $KE^{-\gamma}$ photons $cm^{-2}\ s^{-1}\ keV^{-1}$, and the frequency of occurrence of bursts with different values of γ was studied. It was found that (1) for $\gamma \lesssim 4.0$ the frequency of bursts rapidly decreases with the decrease in the value of γ, (2) the probability of occurrence of a burst with $\gamma \lesssim 2.3$ is extremely small, (3) the exponent δ of the electron spectrum $K_e E_e^{-\delta}$ electrons $cm^{-2}\ s^{-1}\ keV^{-1}$, which is responsible for the x-ray emission at the Sun, has a lower limit so that for most impulsive events $\delta > 1$. (auth)

7417 SOLAR NEUTRINOS. III. COMPOSITION AND MAGNETIC-FIELD EFFECTS AND RELATED INFERENCES. Bahcall, John N. (California Inst. of Tech., Pasadena. Inst. for Advanced Study, Princeton, N. J.); Ulrich, Roger K. Astrophys. J.; 170: No. 3, 593-603(15 Dec 1971).

An improved solar model is shown to yield a calculated capture rate for the ^{37}Cl neutrino experiment that is a factor of 6 larger than the observed rate reported by Davis, Rogers, and Radeha. The ^8B branch must occur a factor of 10 less often than expected on the basis of standard solar models. The effects on the calculated capture rates of a variety of composition uncertainties are considered. The effects of a strong primordial magnetic field are also investigated. The results obtained by several investigators who used different stellar-evolution programs are compared, and it is concluded that the different programs give consistent, but observationally incorrect, results. (auth)

7418 NEGATIVE VISCOSITY PHENOMENON ASSOCIATED WITH THE ROSSBY WAVE ON THE DIFFERENTIALLY-ROTATING SOLAR PHOTOSPHERE. Sakurai, Takeo (Kyoto Univ.). Publ. Astron. Soc. Jap.; 22: No. 2, 177-90(1970).

The Rossby wave on the solar photosphere was investigated from the point of view that the photosphere can be treated as a differentially rotating isothermal spherical shell of nonconducting inviscid ideal gas and that the gravitational effect can be approximated by a Roche-type model. The differentially rotating equilibrium state in which the temperature depends only on the distance from the center of the sphere was obtained, and the linearized local equations for the superposed small disturbances applicable to a strongly stratified solar atmosphere were formulated. The solution clarifies the negative viscosity phenomenon by which the kinetic energy of the disturbance is transferred to that of the main zonal motion of the differential rotation at the cost of damping of the disturbance. (auth)

7419 THERMAL EMISSION FROM THE QUIET CORONA AT 169 MHz DURING THE SOLAR CYCLE. Avignon, Yvette; Lantos, Pierre (Observatoire de Paris, Meudon, France). Compt. Rend., Ser. B; 273: No. 15, 684-5(11 Oct 1971). (In French).

The registration of solar data on the Nancay radio heliograph demonstrated that the 169-MHz flux of the quiet Sun is proportional to variations in the equatorial diameter. Thus the corona brightness temperature and electron temperature are constant during the solar cycle. (France)

7420 DIAGNOSIS OF CORONAL MAGNETIC STRUCTURE BY FLARE-ASSOCIATED HYDROMAGNETIC DISTRUBANCES. Uchida, Yutaka (Tokyo Univ. National Center for Atmospheric Research, Boulder, Colo.). Publ. Astron. Soc. Jap.; 22: No. 3, 341-64(1970).

Mechanical diagnosis of the coronal magnetic structure by the use of flare-associated hydromagnetic disturbances is proposed. The motion and distortion of the so-called Moreton's wave front associated with flare explosions would, in the coronal-wave hypothesis, reflect the propagation condition for hydromagnetic waves along the ray paths lying in the corona. On the basis of the better-known density distribution in the corona, this "seismological diagnosis" will reveal the distribution of the magnetic field in the corona, which has never been measured directly. (W.D.M.)

7421 OBSERVED INTERACTION BETWEEN PROMINENCES. Kawaguchi, Ichiro (Kyoto Univ.). Publ. Astron. Soc. Jap.; 22: No. 3, 405-20(1970).

Two examples of interaction between prominences are presented. Whether the observed behavior of the prominences should be regarded as a real physical interaction between the prominences or only as a chance coincidence due to the projection of two independent prominences on the surface of the sphere is discussed. In these examples, the interaction between the prominences produced deceleration of the descending velocities and may be related to the deformation of the prominences. (auth)

7422 STATISTICAL ANALYSIS OF THE CENTER-LIMB VARIATION OF MICROWAVE IMPULSIVE BURSTS. Scalise, Eugenio Jr. (Tokyo Univ.). Publ. Astron. Soc. Jap.; 22: No. 4, 483-93(1970).

The center-to-limb variation of the observed characteristics of microwave impulsive bursts was studied. The intensity of the bursts near the limb was statistically 1.5 times higher than that of the bursts near the center at 9400 and 1000 MHz, and this ratio was near unity at 2000 MHz and was 0.7 at 3750 MHz. The maximum of the intensity spectrum had a tendency towards the higher frequencies for bursts occuring near the limb. There was evidence that the number of polarized events was smaller for bursts near the limb. (auth)

7423 MAGNETOHYDRODYNAMICAL PROCESSES OF THE SECTOR STRUCTURE IN THE SOLAR WIND. Hirose, Tohru; Fujimoto, Mitsuaki; Kawabata, Kin-aki (Nagoya Univ., Japan). Publ. Astron. Soc. Jap.; 22: No. 4, 495-510(1970).

Effects of the spirally twisted interplanetary magnetic field on the solar-wind velocity and density were investigated in a scheme of linear approximation. It was clarified that the interplanetary magnetic field plays an important role in the solar-wind density variations. The observed longitudinal variation in the solar-wind velocity amounting to 100 km/sec must exist already near the Sun ($r \lesssim 0.2$ AU); such large velocity variations cannot be generated by the interplanetary magnetic field. It is suggested that at $r \sim 0.2$ AU the solar wind with large kinetic energy is ejected from a narrow region less than 40° in the azimuthal angle, where the magnetic field is strong. The solar-wind density variations are discussed under the hypothetical boundary condition that the solar-wind plasma is spherically symmetric at $r \sim 0.2$ AU. It is concluded that the interplanetary magnetic field can generate a large density variation not only in the ecliptic plane but also in the regions away from it. (auth)

7424 OBSERVATION OF THE OUTER LAYER OF THE SUN AT THE TOTAL SOLAR ECLIPSE OF NOVEMBER 12, 1966. Hiei, Eijiro; Hirayama, Tadashi (Tokyo Univ.). Publ. Astron. Soc. Jap.; 22: No. 4, 545-50(1970).

The observation of the total solar eclipse of November 12, 1966 by a slitless spectrograph using the grazing incidence method is described. About 300 spectrograms of the chromosphere and prominences with dispersions of 1.2Å/mm and 1.8Å/mm were successfully obtained at a maximum height resolution of 380 km. Because of the grazing-incidence method, the widths as well as the intensities of emission lines could be measured. A brief description of the spectrograms is given. (auth)

7425 INTERACTION OF COLLISIONLESS SHOCK-WAVE AND STREAM OF PARTICLES IN UPPER SOLAR CORONA. Lacombe, C.; Moeller-Pedersen, B. (Observatoire, Meudon, France). Astron. Astrophys.; 15: No. 3, 406-18(Dec 1971).

Decameter radio observations are reported that point to the interaction between Type-III bursts and a slowly ascending perturbation in the upper solar corona. Radiation enhancements of Type-III bursts are observed at the crossing with the perturbation. An interpretation is proposed in which this perturbation is assumed to be a collisionless shock wave with $T_e > T_i$, exciting a turbulence of ion acoustic waves. The large frequency bandwidth of the radiation enhancement leads to the assumption that the shock front is followed by a long wake where T_e remains larger than T_i. The wake length is determined by the presence of a small number of hot ions which come from the shock front and heat the bulk of ions up to $T_i = T_e$ at the boundary of the wake. Due to $T_e > T_i$ in this wake, the radiation enhancement may be caused by a modification of the nonlinear stabilization process of the instability of the stream which generates the Type III bursts. The influence of wave turbulence on the intensity of a Type-III burst is briefly discussed. (auth)

7426 STATISTICAL INVESTIGATIONS OF THE TIME-DEPENDENT FINE STRUCTURE OF SOLAR BURSTS. Zimmermann, G. (Univ., Kiel). Astron. Astrophys.; 15: No. 3, 433-8 (Dec 1971).

As there exists no theoretical interpretation of the time-dependent fine structure of solar radio bursts, the observed data must be analyzed statistically to give objective results. The purpose of the present work is to provide data for the proper design of a multichannel radiospectrograph for dm wavelengths, and a data reduction and recording system. Methods for the statistical investigation of fine structure were tested. They were applied to paper records of single-channel measurements at 240, 400 to 460, and 1420 MHz made in 1966 and 1967. The preliminary results are the following: histograms of the rise times of fine-structure elements of different bursts at different frequencies are similar except for constant factors. No significant separation of fine structure into different classes with respect to rise and fall times, duration, or form, was found. There is a strong correlation between the various characteristic times of fine-structure elements occurring simultaneously at different frequencies. Mean values of rise times are often independent of time and show little dispersion. (auth)

7427 NATURAL MODES OF THE ACOUSTIC-GRAVITY TYPE IN THE SOLAR ATMOSPHERE. McKenzie, J. F. (European Space Research Inst., Frascati, Italy). Astron. Astrophys.; 15: No. 3, 450-9(Dec 1971).

The dispersion equation is derived for the natural modes of a simple model of the solar atmosphere, which consists of a slab of gas bounded above by a hot gas and below by a cool gas, all under the action of gravity. The periods of the acoustic natural modes, which are of the character of standing acoustic waves within the slab, are confined to a fairly narrow band, in agreement with the 5-minute periodicity observed in the gas motions in the photosphere and chromosphere. By identifying the observed oscillations with these natural modes other observed features of the oscillations, which are in apparent conflict with each other, can be resolved. (auth)

7428 DIFFUSE EXTERNAL REINFORCEMENTS IN THE SOLAR CORONA FROM THE MARCH 7 SOLAR ECLIPSE PLATES. Koutchmy, S. (Institut d'Astrophysique, Paris). Astron. Astrophys.; 16: No. 1, 103-7(Jan 1972). (In French).

Observations of diffuse external reinforcements (R.E.D.) during the March 7th total eclipse are reported. The reality of the R.E.D. was demonstrated by the agreement between the results obtained using different methods and by different authors. The morphology and brightness distribution were studied. The visible light of the R.E.D. seemed to be either unpolarized or slightly polarized in a different way than that, that would be predicted from Thompson scattering. Their position angles appear well correlated with those of active regions. Two effects are proposed to explain the R.E.D.'s: (a) wind or magnetic field effects on circumsolar dust; (b) ejection of neutral gas similar to that of the "disparitions brusques" of the prominences. The physical process giving the observed radiation from R.E.D.'s is not elucidated. Many arguments are given showing that the classical K and F corona concept is insufficient to explain these observations, i.e., the morphology, the relation with solar activity, polarization, the lack of correlation with large coronal streamers, etc. (auth)

7429 FLUCTUATIONS OF TEMPERATURE AND DENSITY IN THE PHOTOSPHERE. Schmieder, B. (Observatoire de Paris, Meudon, France). Astron. Astrophys.; 16: No. 1, 44-52(Jan 1972).

The theoretical calculations of the intensities of two lines of FeI (5196.067 Å and 5195.482 Å) are dealt with, as well as those of a point in the wing of the line b_1 of MgI and of the neighboring continuum in a perturbed atmosphere. It is pointed out that the intensities of the FeI lines are very sensitive to temperature fluctuations whereas the intensity of the continuum is mainly sensitive to density fluctuations. The study of the fluctuations of the measured relative intensities allows one to determine the rms of the temperature and density fluctuations at two altitudes. An attempt is made to evaluate the contribution of the oscillatory phenomenon and the granulation. The fluctuations associated with the granulation in a solar atmosphere model are introduced. In this way, perturbed models are obtained which give variations of the relative brightness fluctuations across the solar disk. The average value of these variations is in good agreement with the results of Edmonds (1962) for $\mu > 0.5$. Considering the fluctuations associated with the oscillatory phenomenon, a radiative minimum relaxation time of about 80 s was determined. (auth)

7430 SOLAR RADIO SPIKE BURSTS. Tarnstrom, G. L.; Philip, K. W. (Univ. of Alaska, College). Astron. Astrophys.; 16: No. 1, 21-7(Jan 1972).

The only common spectral feature of the variety of bursts referred to as spike (or flash) bursts appears to be a duration (at one frequency) of $\lesssim 0.1$ s. High-time-resolution ($\lesssim 0.01$ s) dynamic spectra of bursts thus qualifying as spike bursts may be divided into three categories: fast drift spike bursts, with $|\dot{f}| \geqq 100$ MHz s^{-1}; medium drift spike bursts, with $|f| < 100$ MHz s^{-1}; and simple spike bursts, of ≈ 1 MHz bandwidth and no apparent frequency drift. All categories of spike bursts tend to occur in regular sequences of similar bursts. (auth)

7431 TIME VARIATION OF MEAN CHARACTERISTICS OF THE SUN'S POLAR MAGNETIC FIELD. Grigor'ev, V. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Novosibirsk, USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 3, 516(Nov-Dec 1971).

Translated from Astron. Zh.; 48: No. 3, 653(May-Jun 1971).

The time variation of the mean values for the strength and size of magnetic field elements was investigated. A decrease was discovered in the mean size of the magnetic elements by the time of the solar activity maximum. The strength of the magnetic field elements did not change substantially. (auth)

7432 HIGH-RESOLUTION OBSERVATIONS OF TYPE-III SOLAR RADIO BURSTS. Elgaroey, Oe.; Lyngstad, E. (Oslo Univ.). Astron. Astrophys.; 16: No. 1, 1-12(Jan 1972).

Solar radio bursts of spectral Type III were observed, using high-resolution radio spectrographs operating in the frequency ranges 310 to 340 MHz and 145 to 175 MHz. The average frequency drift velocity amounted to –150 MHz/s in the 300-MHz range and –63 MHz/s in the 150-MHz range. A long-term variation in the average drift velocity was possibly present. No bursts were found having a duration smaller than about 0.2 s. The average half-power duration at 318 MHz was 0.8 s. At 159 MHz it amounted to 1.5 s. At 225 MHz the average energy of Type III bursts was 0.7×10^{-20} joule m^{-2} Hz^{-1}. A calibrated radiometer was used for observations at this frequency. Comparing the results with data from observations at lower frequencies, it was found that the energy increases with decreasing frequency. Type III bursts normally occur in groups. The average number of bursts in the groups was 11 and most frequently successive bursts occurred with a time separation around 1 s. The average time distance amounted to about 3 s. Using characteristic decay times and assuming damping by collisions, coronal temperatures of the order of some million degrees were derived. At the 318-MHz level the extension in depth of the exciting disturbance was about 70,000 km and at the 159 MHz level it increased to 130,000 km. This indicated a velocity of expansion in the radial direction of the order of 40,000 km/s. A discussion of the observational results is given. (auth)

7433 SOLAR MAGNETIC FIELD GENERATION BY GYROTROPIC TURBULENCE. Vainshtein, S. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 3, 503-5(Nov-Dec 1971).

Translated from Astron. Zh.; 48: No. 3, 640-2(May-Jun 1971).

The difficulties that arise when explaining the solar cycle by means of the α effect are pointed out. The calculation shows that the explanation of the inverse relation between the toroidal and meridional fields, with application of the α effect, is not satisfactory. (auth)

7434 VISCOUS TORSIONAL OSCILLATIONS AND THE CYCLES OF SOLAR ACTIVITY. Iroshnikov, R. S. (State Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.): 15: No. 3, 432-6(Nov-Dec 1971).

Translated from Astron. Zh.: 48: No. 3, 549-55(May-Jun 1971).

A detailed examination was made of a mechanism, proposed earlier, of torsional oscillations in a viscous medium as a possible cause of the cycles of solar activity. It is shown that the excitation of such oscillations would require an inadmissibly strong magnetic field. Moreover, it is shown that, if such oscillations were realized, they would almost surely take place without any time variation of the direction of the magnetic field, in sharp contradiction to observations. Thus, the mechanism examined, in comparison with the dynamo mechanism for explaining the cycles of activity, is of no value. (auth)

7435 PLASMA TURBULENCE IN SOLAR FLARES. Tomozov, V. M. (State Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 3, 437-43(Nov-Dec 1971).

Translated from Astron. Zh.: 48: No. 3, 556-64(May-Jun 1971).

A comparative analysis was made of the solar-flare models of Petchek and Syrovatskii, and it was concluded that Petchek's mechanism is inadequate in energy. The article examines the general physical picture of the development of plasma turbulence in the current-conduction layer for the solar-flare model proposed by Syrovatskii. It is shown that in the process of establishing the current-conduction layer, there develops a Buneman instability that intensely heats the electrons and ultimately results in a nonisothermal plasma; then ionosonic vibrations are generated, decreasing conductivity; and, finally, due to nonlinear conversion of ionosonic s-plasmons to Langmuir l-plasmons, a high-frequency plasma turbulence appears. The estimates made permit one to assert that, in the plasma of a conduction layer, the energy densities of l- and s-plasmons can be comparable. (auth)

7436 POSSIBLE NATURE OF SHORT-PERIOD PULSATIONS IN THE SOLAR ATMOSPHERE. Brengauz, V. D. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.): 15: No. 3, 444-7(Nov-Dec 1971).

Translated from Astron. Zh.: 48: No. 3, 565-9(May-Jun 1971).

The propagation of magnetosonic waves is discussed for the case of the solar atmosphere in the region of a temperature minimum and a uniform magnetic field H_0 oriented perpendicular to the acceleration of gravity. It is shown that certain properties of the short-period pulsations which are observed in this region can be explained through the assumption that the appearance of oscillations is due to waveguide propagation of the slow magnetosonic mode. (auth)

7437 MARCH 30, 1969 SOLAR FLARE EVENT. Palmeira, R. A. R.; Bukata, R. P.; Gronstal, P. T. (Univ. of Texas, Dallas). pp 231-45 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. I. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.1).

A study of the March 30, 1969 solar-flare event is presented, utilizing data obtained from the world-wide network of neutron monitors. Although, to a good first approximation, the solar-flare radiation displayed a high degree of isotropy at the orbit of the Earth, it is deduced that a small anisotropy from East of the Earth–Sun line was present at the time of maximum enhancement of the event. This small deduced anisotropy does not, however, preclude the use of a method, based on isotropic particle propagation, to calculate the rigidity spectral index of the flare-induced radiation. Use of such a method determines the differential rigidity spectral index to be 3.9 ± 0.1. Additional data from the low-energy detectors on board the Pioneer 8 and 9 deep-space probes are used to try to determine the location of the parent solar flare. The most probable location is found to be ~20° beyond the solar Western limb. (IAA)

7438 SOLAR-MICROWAVE BURSTS ASSOCIATED WITH HIGH-ENERGY ELECTRONS. Bland, C. J. (Univ. of Calgary, Alberta). pp 246-54 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. I. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.1).

During the Feb. 25, 1969 event, during which solar electrons in the several-MeV energy range were recorded by satellite instruments, an intense solar microwave burst also occurred. It is shown that the characteristic features of the microwave spectrum previously noted as being indicative of solar high-energy particle production are consistent with synchrotron radiation. Thus it may be possible to obtain a measure of the spectrum of high-energy solar electrons close to their point of production and later after propagation through the interplanetary medium. Such a possibility offers a chance of investigating the propagation medium and elucidating the properties responsible for the features of the arrival of solar particles near the Earth as well as the modulation of cosmic rays. (auth) (IAA)

7439 OBSERVATION OF THE HARD SOLAR X-RAY BURST OF FEBRUARY 11, 1970 AT SYOWA STATION, ANTARCTICA. Kodama, M. (Inst. of Physical and Chemical Research, Tokyo); Kusunose, M.; Ogura, K.; (and others). pp 255-69 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. I. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.1).

A balloon-borne NaI scintillation detector launched from Syowa Station in Antarctica recorded an about 100-fold enhancement per 30 sec of the energetic x-ray flux above 25 keV at a height of 7 g/cm^2 during a solar flare of class 2B started on 0704 UT of February 11, 1970. The x-ray burst commenced on about 0706 UT, when the solar microwave bursts also started, and lasted for nearly 7 min. The time profile of both the x-ray and microwave bursts is very simple in form, showing only two peaks each of which is characterized by different x-ray energy spectra in association with different radio-frequency spectra. The time of the double x-ray peaks is independent of x-ray energies from 25 keV to 200 keV and almost coincides with that of 35-GHz radio bursts. However, the time delay of microwaves other than 35 GHz is found to increase with decreasing radio frequency, amounting to about 2 min in the case of a 1-GHz radio burst. In addition, it is shown that a quasi-periodic variation of x-ray intensities with a period of about 6 sec is included in the first peak event. (auth)

7440 COMMENT ON "OBSERVATION OF THE HARD SOLAR X-RAY BURST OF FEBRUARY 11, 1970 AT SYOWA STATION, ANTARCTICA," M. KODAMA ET AL. Maeda, Kaichi (Goddard Space Flight Center, Greenbelt, Md.). pp 270-2 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. I. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.1).

The solar x-ray burst observed by the balloon at Antarctica on Feb. 11, 1970 (see preceding abstract) was also detected by a U. S. satellite, OSO–V. This is the first solar burst event measured simultaneously by balloon and satellite with comparable instruments. The two energy ranges obtained by the CsI(Na) scintillator of OSO–V were 28 to 55 keV on one channel and 82 to 111 keV on the other. A comparison of the satellite and balloon data is made. (J.C.W.)

Galaxies

7441 SOME UNUSUAL SOUTHERN HEMISPHERE OBJECTS. Lue, Phillip K. (Western Connecticut State Coll. Observatory, Danbury). Astron. J.: 76: No. 9, 775-6(Nov 1971).

Positions, finding charts, and descriptions are given for 40 unusual objects in the southern hemisphere. These unusual objects, which appear to be mostly peculiar galaxies or galactic nebulosities, were found from an examination of photographic plates taken with the 20-inch double astrograph of the Yale–Columbia Southern Observatory. (auth)

7442 EFFECT OF THE EINSTEIN LIGHT DEFLECTION ON OBSERVED PROPERTIES OF CLUSTERS OF GALAXIES. Noonan, Thomas W. (Brockport State Coll., N. Y.). Astron. J. 76: No. 9, 765-7(Nov 1971).

Inhomogeneities in the background of field galaxies due to the deflection of light by the mass of a cluster of galaxies introduce an overestimate of the cluster population no larger than the order of a percent, depending on the nature of the unseen cluster mass. Focusing by the cluster mass causes a brightening of background galaxies seen through the cluster. (auth)

7443 EFFECT OF SHOCK WAVE DISSIPATION ON STABILITY OF THE INTERSTELLAR MEDIUM. Burke, J. Anthony (Victoria Univ., British Columbia). Mon. Notic. Roy. Astron. Soc.: 154: No. 4, 385-91(1971).

Heating of the interstellar medium by dissipation of weak shock waves adds somewhat to its stability against gravitational collapse or thermal changes. The range of gravitationally unstable long wavelengths is generally diminished, and the tendency toward thermal instability at short wavelengths is lessened. (auth)

7444 MAPPING OF NEUTRAL HYDROGEN IN GALAXIES BY APERTURE SYNTHESIS TECHNIQUES. Baldwin, J. E.; Field, C.; Warner, P. J.; Wright, M. C. H. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc.; 154: No. 4, 445-54 (1971).

The problems of observing neutral hydrogen in external galaxies with high angular resolution are discussed. The operation of an aperture synthesis telescope with a cross correlation spectrometer giving an angular resolution better than 1′ arc with a velocity resolution of 39 km s^{-1} is described. (auth)

7445 IRRADIATED QUARTZ PARTICLES AS INTERSTELLAR GRAINS. Wickramasinghe, N. C. (Cambridge Univ., Eng.). Nature (London) Phys. Sci.; 234: No. 44, 7-10(1 Nov 1971).

The possibility that quartz particles irradiated by cosmic rays or x rays may be able to account for the observed properties of interstellar grains over the wavelength range ~1600 Å to 20 μm is discussed. (auth)

7446 RADIOFREQUENCY RECOMBINATION LINES AS DIAGNOSTICS OF THE COOL INTERSTELLAR MEDIUM. Dupree, A. K. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J.; 170: No. 3, L119-23(15 Dec 1971).

Intensity ratios of α and β transitions of recombination lines can be used to determine the temperature and electron density in H I clouds. The few available observations of the carbon line in Orion A and NGC 2024 suggest preliminary values of $N_e \gtrsim 1$ cm^{-3} for $T_e \lesssim 100$°K. (auth)

7447 100-MICRON SURVEY OF THE GALACTIC PLANE. Hoffmann, William F.; Frederick, Carl L.; Emery, Roger J. (Goddard Inst. for Space Studies, New York). Astrophys. J.; 170: No. 3, L89-97(15 Dec 1971).

A survey of a portion of the galactic plane was carried out at a wavelength of 100 μ with a beamwidth of 12′ and a sensitivity of 10^{-22} W m^{-2} Hz^{-1}. The survey covered 750 square degrees of the sky including most of the galactic plane between $l^{II} = 335°$ and $l^{II} = 88°$ and a number of other selected areas of interest. Seventy-two sources were detected, 60 of which were identified with continuum radio sources, bright nebulae, dark nebulae, and infrared stars. (auth)

7448 NOTE ON N GALAXIES AND MINI-QUASARS. Lynden-Bell, D. (Royal Greenwich Observatory, Herstmonceux, Eng.). Mon. Notic. Roy. Astron. Soc.; 155: No. 1, 119-27(1971).

A comparison of the properties of quasars and N galaxies suggests that they form a continuous distribution. The observed numbers of N galaxies then provide further information on the luminosity function of the quasars. (auth) (UK)

7449 EQUIPARTITION IN GALACTIC NUCLEI AND GRAVITATING SYSTEMS. Saslaw, William C. (Univ. of Virginia, Charlottesville. National Radio Astronomy Observatory, Green Bank, W. Va. Cambridge Univ., Eng.); De Young David. Astrophys. J.; 170: No. 3, 423-9(15 Dec 1971).

It is shown that, under very general conditions, self-gravitating systems with particles of different mass cannot be in equipartition. A prescription is also derived for determining whether equipartition can exist for a given distribution. (auth)

7450 PERSISTENCE OF THE WAVE SPIRAL PATTERN IN GALAXIES. Marochnik, L. S. (Rostov State Univ., Rostov-on-Don, USSR); Suchkov, A. A. Astrophys. Lett.; 9: No. 1, 37-8 (Aug 1971).

It is shown that the Landau instability of spiral density waves in a galaxy is an absolute one. Therefore, the obliteration of the wave spiral pattern would not take place in spite of the dispersion of the wave packet. It is found that the distortion of the wave spiral pattern by the differential rotation in the Galaxy takes place in 20 revolutions of the Galaxy. (auth)

7451 GRAPHITE-SILICATE GRAIN MIXTURES AND THE DIFFUSE GALACTIC LIGHT. Wickramasinghe, Nalin Chandra (Kyoto Univ.). Publ. Astron. Soc. Jap.; 22: No. 1, 85-91(1970).

The mean albedoes and phase parameters were computed for various combinations of graphite particles, silicate grains, and silicate grains covered with ice mantles. Graphite–silicate grain mixtures that produce good agreement with the interstellar extinction curve and with the wavelength dependence of interstellar polarization possess albedoes and phase functions that are consistent with available data on the diffuse galactic light. (auth)

7452 FORMATION OF STELLAR SYSTEMS BY ISOTHERMAL FRAGMENTATION. Sasao, Tetsuo (Tokyo Univ.). Publ. Astron. Soc. Jap.; 22: No. 2, 129-35(1970).

An isothermal fragmentation process is studied from energetic considerations. The radius of the initial gas sphere of the stellar system is obtained as a function of the number of the components. The result seems to suggest the common origin of the Galaxy and globular clusters from a proto-galaxy. (auth)

7453 TWO CONTINUUM SURVEYS ALONG THE GALACTIC PLANE AT 8000 MHz. Kawajiri, Nobuhiro (Radio Research Labs., Kashima, Japan). Univ. of Michigan, Ann Arbor). Publ. Astron. Soc. Jap.; 22: No. 2, 165-75(1970).

Two galactic continuum surveys were made at 8000 MHz using the 85-ft radio telescope at the Radio Astronomy Observatory, the University of Michigan. The areas covered were: region 1, between the galactic longitudes of 30 and 36°, where the celestial and the galactic equators intersect each other (the cross region); and region 2, between the galactic longitudes of 80 and 89° and latitudes of roughly ±4°, which contains NGC 7000 (the North American nebula) and a part of Cyg X region. A total of 58 and 59 discrete sources having antenna temperatures mostly greater than 0.3°K were detected for region 1 and region 2, respectively. The radio contour map and the list of sources for each region are presented. There is no conspicuous radio peak in the North American nebula, but the peak consists of several small peaks with antenna temperature of 0.3 to 0.5°K distributing from the central part of the optical nebula towards the western part of the nebula and the Pelican nebula. The brightness of the galactic background radiation is very low. Thus, the contribution of thermal emission to the background must be very small. (auth)

7454 VELOCITY DISTRIBUTION FUNCTION IN A ROTATING DISK-LIKE STELLAR SYSTEM AND HYDRODYNAMIC EQUATIONS. Kato, Shoji (Tokyo Univ.). Publ. Astron. Soc. Jap.; 22: No. 3, 285-98(1970).

The velocity distribution function in a rotating disk-like collisionless stellar system was examined. The system might deviate from axisymmetry and steadiness, having macroscopic motions over the rotation. It is assumed, however, that the rotation is so rapid that the shortest time scale of the system is the time scale of rotation. The velocity distribution function in such a system was investigated by a method of successive approximations similar to the one known in the study of collisionless plasma with short gyration period of particles. It was found that i) the directions of the principal axes of the velocity dispersion deviate from the radial and longitudinal directions with the axial ratio being changed from $[(B - A)/B]^{1/2}$, where A and B are Oort's constants, and ii) the distribution of peculiar velocity is asymmetric with respect to the reverse of the direction of the velocity. The deviation of the principal axes is due to the superposition of macroscopic motions over the rotation, while the asymmetry of the velocity distribution is related to the spatial variation of the magnitude of the velocity dispersion and the rotation law of the system. The results can explain the observed vertex deviation and asymmetric distribution of high velocity stars in the solar neighborhood. In addition, iii) the hydrodynamic equations governing the macroscopic motions were obtained. These equations might be useful to study the evolution of the stellar system. (auth)

7455 SEARCH FOR INTERPLANETARY DUST. Brownlee II, Donald Eugene. Seattle; Univ. of Washington (1971). 245p. University Microfilms Order No. 71-28,384.

Thesis.

Experiments were conducted with the purpose of collecting interplanetary particulate matter in the micron-size range. Four experiments were conducted in the stratosphere using high-altitude balloons, three in the mesosphere with sounding rockets, two in Earth orbit using manned satellites, and one on the lunar surface as a result of the return of the Surveyor III TV camera by Apollo 12. The satellite and lunar experiments set highly reliable upper limits on the flux of micron-sized micrometeoroids at 1 A. U. (TSS) (Diss. Abstr. Int., B)

7456 POSSIBILITY THAT THE FAR-ULTRAVIOLET EXCESS IN M31 IS DUE TO MAIN-SEQUENCE STARS. Tinsley Beatrice M. (Univ. of Texas, Dallas). Astron. Astrophys.; 15: No. 3, 403-5(Dec 1971).

The far-ultraviolet (uv) excess in the central region of M31, observed by OAO–2, could be due to young main-sequence stars. More-than-enough such stars are present in the model for the M31 inner disk population derived by Tinsley and Spinrad (1971) to match line and color indices at longer wavelengths. If the far-uv radiation of typical galaxies arises from young stars, the theoretical uv background is enhanced greatly by evolutionary effects. For evolution at the rate of Tinsley and Spinrad's model for M31, or of Arnett's (1971) "linear" model for the Galaxy, the enhancement is a factor 2.5 to 14, depending on the Hubble constant and the spectrum at wavelengths below 1700 Å. (auth)

7457 NONSPHERICAL AND FINITE-AMPLITUDE PULSATIONS OF A UNIFORM GASEOUS SPHERE. Mizuno, Takao; Fujimoto, Mitsuaki (Nagoya Univ., Japan). Publ. Astron. Soc. Jap.; 22: No. 4, 413-22(1970).

Finite-amplitude and nonspherical pulsations of a uniform gas cloud in smooth gravitational contraction were computed by assuming a special formula $\kappa\rho^nT$ for the cooling rate of the gas, where κ and n are given constants, and ρ and T designate density and temperature, respectively. Initial perturbations, both spherical and nonspherical, were applied to the gas cloud. They either grow or are damped, depending on the sign of n in the assumed formula for the cooling law. These characteristic motions can be understood by a linear approximation. Nonspherical gravitational collapses are briefly discussed. If the gas pressure is sufficiently large at maximum compression, bouncing motion occurs. It is found in some cases that the oblate cloud results in an elongated one after the bouncing motion; the final configuration cannot be predicted only from the initial perturbation. (auth)

7458 NEUTRAL HYDROGEN IN AN INTERIOR REGION OF THE GALAXY; THE LONGITUDE INTERVAL 22^0 TO 42^0. III. THE SCUTUM ARM. Shane, W. W. (Leiden Observatory). Astron. Astrophys.; 16: No. 1, 118-48(Jan 1972).

Neutral hydrogen observations described in preceding papers were used to construct a schematic map of the Galaxy in the region where the Scutum arm is seen tangentially, between 4.0 and 6.5 kpc from the galactic center. For this purpose, a kinematic model was adopted in which a radial expansion is superimposed upon a velocity field derived from the first-order density-wave theory. Neutral hydrogen was found in several concentrations, the strongest being the main branch of the Scutum arm, which is located about 5.5 kpc from the galactic center and obeys roughly the density-wave kinematics, and an inner arc about 4.5 kpc from the center, which appears to show much stronger noncircular motions. The transition between these two regions is marked by a concentration of HII regions and by a pronounced increase of HI density and a decrease of turbulent velocity with increasing distance from the center. As an alternative to the assumption of radial expansion, it was found that some, but not all, of the suspected deviations from the first-order density-wave velocity field at $\varpi > 3.5$ kpc can be explained if the inner HI concentration is identified with a resonance ring. In addition to the HI population studied, which is strongly concentrated to the galactic plane (D component), the presence of a second HI population less concentrated to the galactic plane and with higher turbulent velocities (E component) was noted. The E component accounts for about 20% of the HI in the region studied. (auth)

7459 PHOTOELECTRIC H_α SURFACE PHOTOMETRY OF THE SMALL MAGELLANIC CLOUD. Schmidt, Th. (Max-Planck-Institut fuer Aeronomie, Heidelberg). Astron. Astrophys., 16: No. 1, 95-102(Jan 1972).

Photoelectric H_α + [N II] surface photometry of the Small Magellanic Cloud was undertaken by means of the Heidelberg 50-cm Cassegrain-reflector at the Boyden Observatory, South Africa. The most active region of H_α + [N II] excess radiation ΔI_{H_α} is not the optical and 21-cm brightness center, but areas in the northeastern "bar" extension and in the "wing" which seem to be connected with Hindman's (1967) expanding HI shell No. 1. Within these regions the quantum flux of the exciting Lyman continuum radiation, derived from $\Delta I_{H\alpha}$, is nearly equal to the Lyman emission of a star sample with the observed visual surface brightness, adopting a zero-age luminosity function, whereas the Lyman emissivity would be far too low for an evolved luminosity function. The overall H_α excess maximum in the NE bar extension is displaced from the associated H I maximum by 400 ± 100 pc, for the wing maxima a somewhat smaller displacement is indicated. The red brightness distribution (without H_α) is clearly peaked at the general optical and 21 cm brightness center in the SW bar, no maxima occur within the wing and the NE bar extension. (auth)

7460 STABILITY OF FLAT ROTATING GALAXIES WITH MAGNETIC FIELD. Polyachenko, V. L.; Fridman, A. M. (Novosibirsk State Univ., USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 3, 396-401(Nov-Dec 1971).
Translated from Astron. Zh.; 48: No. 3, 505-12(May-Jun 1971).

An analysis was made of the stability of a rotating, conducting disk in a magnetic field directed parallel to the rotation axis. The initial system of linearized magnetohydrodynamic equations is shown to be self-adjoint for the case of radial disturbances, thereby permitting the formulation (as an integral equation) of the energy principle originally established by Lundquist for systems at rest. A criterion was obtained for the centrifugal instability of the system; if the density is uniform it agrees with the Rayleigh criterion in hydrodynamics. Since the maximum increment of gravitational instability falls in the short-wavelength region, the integral equation is reduced to the case of short-wave perturbations. The dispersion equation obtained in this manner agrees with the relation obtained previously by the authors, except that the sound velocity is here replaced by the Alfvén velocity. Thus the disturbances of shortest wavelength will be stabilized by the magnetic-pressure force, just as found previously. By introducing numerical values for the basic parameters of the Galaxy, it is shown that the present magnetic-field strength in the spiral arms is adequate to stabilize disturbances whose wavelength is roughly equal to the thickness of the disk (at the limit of applicability of the model considered here). (auth)

7461 GALAXIES OF LOW SURFACE BRIGHTNESS. Vorontsov-Vel'yaminov, B. A.; Noskova, R. I. (Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 3, 402-5 (Nov-Dec 1971).
Translated from Astron. Zh.; 48: No. 3, 513-17(May-Jun 1971).

A statistical survey was made of about 1500 galaxies whose intensity at the brightest point was estimated as 4 or fainter in the Morphological Catalog of Galaxies, or 3 on the same scale if the object was turned edgewise. Over one-half of these galaxies were only moderately faint in surface brightness but had an integrated brightness fainter than 15m pg and were less than $1'$ across. Most of them were presumably spiral galaxies, although in one-half of them no spiral arms were visible. Irregulars comprised 12% of the objects, not including the edge-on systems. Spheroidal Sculptor-type galaxies were encountered primarily in the Virgo cluster. The great majority of the galaxies of low surface brightness are late-type systems, mainly barred spirals and irregulars. The apparent distribution over the sky differed somewhat, depending on the integrated magnitude, surface brightness, angular diameter, and morphological type. (auth)

7462 EVOLUTION OF A MULTI-PHASE SPACE DENSITY COLLISIONLESS ONE-DIMENSIONAL STELLAR SYSTEM. Cuperman, S.; Harten, A. (Tel-Aviv Univ., Israel). Astron. Astrophys.; 16: No. 1, 13-20(Jan 1972).

The evolution in time of collisionless one-dimensional stellar systems was investigated for the case of a four-phase-space density configuration. The investigation was carried out by following the motion of the boundary curves enclosing the four-phase-space regions, each of which is characterized by a different phase space density. A partial qualitative agreement with Lynden-Bell's prediction that the velocity dispersions should be inversely proportional to the initial phase space densities was found. (auth)

7463 KINEMATIC STUDY OF IONIZED HYDROGEN IN THE LARGE MAGELLANIC CLOUD. Cheriguene, M. F.; Monnet, G. (Observatoire, Marseille). Astron. Astrophys.; 16: No. 1, 28-37 (Jan 1972). (In French).

The radial velocities of 120 H II regions in the Large Magellanic Cloud were obtained by the interference method using the $H\alpha$ line, with a mean dispersion of 20 Å mm^{-1}. 1200 points were measured on 63 plates. A comparison with the former published velocities (HII regions or neutral hydrogen) showed a systematic difference. A rotation curve was drawn by assuming a negligible expansion. (auth)

Cosmology

Refer also to abstract 8057.

7464 COMPLETE REDSHIFT-MAGNITUDE FORMULA. Kaufman, Sheldon E. (New York Univ., N. Y.). Astron. J.; 76: No. 9, 751-5(Nov 1971).

A closed formula for the relation between luminosity and redshift in an expanding Friedman universe with vanishing pressure is found which is valid for all values of the cosmological constant and the three possible space curvatures. The formula is tested with the well-known special cases. (auth)

7465 MORE QUALITATIVE COSMOLOGY. Collins, C. B. (Dept. of Applied Mathematics and Theoretical Physics, Cambridge, Eng.). Commun. Math. Phys.; 23: No. 2, 137-58(1971).

Standard geometric techniques of differential equation theory were employed to determine the qualitative behavior of a set of nonrotating perfect-fluid cosmologies, whose spatially homogeneous hypersurfaces admit a 3-parameter group of isometries of Bianchi types I, II, III, V, or VI. In this way one is led to some new exact solutions of the field equations. The field equations for a broad class of cosmological models are presented in a regularized form, limitations on the use of this procedure are examined, and some suggestions are made on ways of avoiding the difficulties that arise. (auth)

7466 REMOVAL OF INITIAL SINGULARITY IN A BIG-BANG UNIVERSE IN TERMS OF A RENORMALIZED THEORY OF GRAVITATION. II. CRITERIA FOR OBTAINING A PHYSICALLY REASONABLE MODEL. Nariai, Hidekazu; Tomita, Kenji (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 3, 776-86(Sep 1971).

On the basis of the renormalized theory of gravitation proposed in a previous paper, an attempt is made to construct a homogeneous and isotropic expanding model Universe free from the initial singularity of infinite density and that tends asymptotically to the usual Friedmann universe. Numerical integrations of the cosmological equations show that such a model can exist, provided that the temperature at the instant of bounce is not lower than about 10^{12}°K and that temporal behavior of the model before and after the bounce is considerably different from each other. Physical significances of these two criteria are also mentioned in each case in connection with the problems concerning the formation of elementary particles and the past–future symmetry of the Universe. (auth)

7467 CAN A NEUTRAL TACHYON FIELD EXIST? Phillips, P. R. (Washington Univ., St. Louis). Nature (London) Phys. Sci.; 234: No. 46, 55-6(15 Nov 1971).

It is stated that if a tachyon field is neutral some interesting conclusions can be drawn from a classical and statistical treatment, without going into the intricacies of quantisation. Some of the implications of such a field are discussed, first assuming that it is scalar and then discussing the case of a vector field. Because it cannot readily be shielded, the tachyon field is even more pervasive than the 3K background radiation and can be used in a similar way to define a preferred frame of reference. It would be expected that a breakdown of Lorentz invariance would be observed, and failure to do this is evidence against the existence of such a field. Two points, however, are considered: firstly, the evidence for Lorentz invariance is not complete, and theories may exist in which the invariance fails but electrodynamics, the basis of classical tests, survives unchanged; and secondly, if the problem of Lorentz invariance can be circumvented, the tachyon field provides an interesting way of correlating the proton mass with the rest of the matter in the Universe. Investigations as to whether there are objections to the tachyon field theory, apart from violation of Lorentz invariance, are discussed. (UK)

7468 ELECTRON–NEUTRINO CROSS SECTION AND ITS EFFECT ON THE COSMOLOGICAL HELIUM ABUNDANCE. Hecht, Hartmut F. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 170: No. 3, 401-4(15 Dec 1971).

The result of a calculation of the ^{4}He abundance produced in the early stages of expansion of the Universe is presented. It is assumed in the calculation that the electron–neutrino scattering cross section is sufficiently large to maintain thermal equilibrium between the neutrinos and the photons and electrons in the primordial gas. (auth)

7469 THERMODYNAMICS AND COSMOLOGY. Kovetz, A. (Univ. of Montreal). Astrophys. Lett.; 9: No. 1, 17-18(Aug 1971).

The equations of cosmology are reformulated to account for the existence of a bulk viscosity, and some of the consequences are discussed. (auth)

7470 INTERACTION OF FAST PARTICLES WITH INTERGALACTIC MATTER. Arons, Jonathan (Princeton Univ. Observatory, N. J.); McCray, Richard; Silk, Joseph. Astrophys. J.; 170: No. 3, 431-47(15 Dec 1971).

A discussion is given on the relaxation of power-law cosmic-ray spectra in the intergalactic medium. The theoretical time-dependent spectra obtained are used to calculate the nonthermal radiation produced by bremsstrahlung of subcosmic-ray electrons colliding with ambient protons of the intergalactic gas. A comparison is made between the theory and the observations of the diffuse x-ray and γ-ray background. The calculated cosmic-ray proton spectra are applied to a computation of the heating of the intergalactic medium, and the resulting thermal bremsstrahlung radiation is compared with the suprathermal proton bremsstrahlung flux. It is concluded that nonthermal bremsstrahlung is unlikely to be an important contributor to the isotropic x- and γ-ray background. However, cosmic-ray heating can provide a plausible heat source for maintaining a hot intergalactic gas, especially when evolutionary effects are included in the distribution of cosmic-ray sources. (auth)

7471 GRAVITATIONAL FIELD OF A BOUNDED SOURCE IN GENERAL RELATIVITY. Persides, S. (Univ. of Texas, Austin). Astrophys. J.; 170: No. 3, 479-98(15 Dec 1971).

The gravitational field of a bounded and isolated material source is expressed explicitly in terms of the density, pressure, and other characteristics of the source in a scheme of successive approximations. Particular emphasis is given to the radiation zone and to the relation of the gravitational waves to the source. The approximation method is established for a general source. The components of the metric tensor in a coordinate system t, x, y, and z are written as an infinite sum of terms with each term being identified by the factor ϵ^i ($\epsilon = c^{-1}$), which the term contains. To describe the emission of gravitational energy, independent coordinates u, x, y, and z are chosen (instead of t, x, y, z), with u becoming the retarded time and x, y, z the usual Cartesian coordinates at spatial infinity. The Ricci tensor is expanded in a power series of ϵ, and the gauge condition is determined by the requirement that the metric must reduce to the Minkowskian metric at spatial infinity. With the energy–momentum tensor given in general terms, the inhomogeneous field equations are written in the ith approximation, and the procedure for determining the news function and the rate of energy radiation is described. The method is applied for a bounded source of perfect fluid. The energy–momentum tensor is expanded in powers of ϵ, and the field equations are solved explicitly for the first four approximations ($i = 1, 2, 3, 4$) after the Minkowskian metric. The integrability conditions for the Einstein equations are derived. Finally, the field in the radiation zone is related to the source by calculating explicitly the first nonzero term of the news function and the rate at which energy is radiated in the form of gravitational waves. (auth)

7472 STABILITY OF PRECESSING ELLIPTICAL ORBITS IN A SCHWARZSCHILD FIELD. Hansen, R. O. (Univ. of Chicago). Astrophys. J.; 170: No. 3, 557-8(15 Dec 1971).

It is shown that orbits in a Schwarzschild metric of central mass M for which $l \leq (3 + e)2GM/c^2$, where e is the eccentricity and l is the semi-latus rectum of the elliptical orbit in a suitably defined rotating frame, are unstable. (auth)

7473 FLUID DYNAMICS FOR COSMOLOGY. Kihara, Taro; Sakai, Kazuo (Tokyo Univ.). Publ. Astron. Soc. Jap.; 22: No. 1, 1-12(1970).

The equation of continuity and the equation of motion for fluids in early and later stages of the expanding Universe are given in most-intuitive forms. On the basis of these equations, the adiabatic invariance of certain integrals is proved. The formulation is effective for explaining the process of the concentration of matter into galaxies. (auth)

7474 THERMAL INSTABILITY IN AN EXPANDING MEDIUM. Kondo, Masa-aki (Tokyo Univ.). Publ. Astron. Soc. Jap.; 22: No. 1, 13-40(1970).

Thermal instability in an isotropically expanding (or contracting) medium is studied, including the gravitational and pressure effects, using hydrodynamical and thermal equations derived in simple forms. The effects of the motion of unperturbed state appear in the momentum equation as a drag force and the variation in the Jeans wavelength. Thermal instability of infinitesimal fluctuations is analyzed and the result is shown conveniently in the three-dimensional space of $\partial L/\partial T$, $\partial L/\partial \rho$, and wave number, where L is a heat-loss function. The marginal state is considerably affected by the motion of the unperturbed state. The expansion has the tendency of stabilizing the gravitational mode. This effect, however, is not large if the growth rate of perturbations is much greater than that of free fall. The wave-number dependence of the growth rate, which reflects the gravitational and pressure effects, is classified by the growth rates of all modes at the long- and short-wave-number limits. The ordinary model of the expanding Universe is shown to be in a thermally stable state due to Compton scattering, irrespective of whether the radiation and the matter are thermally coupled or decoupled. However, if the matter temperature is high enough after the decoupling, as proposed by Sofue (1969), thermal excitation of fluctuations strongly occurs due to free–free processes under the condition that the kinetic energy of turbulence is continually dissipated into heat. (auth)

7475 POSSIBLE EVIDENCE FOR THE EXISTENCE OF ANTIMATTER ON A COSMOLOGICAL SCALE IN THE UNIVERSE. Stecker, F. W.; Morgan, D. L. Jr.; Bredekamp, J. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev. Lett.; 27: No. 21, 1469-72(22 Nov 1971).

Some initial results of a detailed calculation of the cosmological γ-ray spectrum from matter–antimatter annihilation in the Universe are presented. The similarity of the calculated spectrum with the present observations of the γ-ray background spectrum above 1 MeV suggests that such observations may be evidence of the existence of antimatter on a large scale in the Universe. (auth)

7476 ORIGIN OF MAGNETIC FIELDS IN AN EXPANDING UNIVERSE. MAGNETO-FLUID DYNAMICAL THEORY. Kihara, Taro; Miyoshi, Kazunori (Tokyo Univ.). Publ. Astron. Soc. Jap.; 22: No. 3, 245-53(1970).

It has been shown that Batchelor's condition for spontaneous appearance of magnetic fields in the turbulent motion of a conducting fluid likewise holds in the case of an expanding universe, and that the early Universe with homogeneous density satisfies this condition. Thus the galactic magnetic fields can be understood as remains of those which existed before the birth of galaxies. (auth)

7477 BREMSSTRAHLUNG MODEL FOR THE X-RAY BACKGROUND. Prilutskii, O. F.; Rozental, I. L. (Inst. for Space Research, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 3, 385-9(Nov-Dec 1971).

Translated from Astron. Zh.; 48: No. 3, 489-95(May-Jun 1971).

Several authors have recently discussed models for the x-ray background in which the bremsstrahlung of photons by intergalactic subcosmic electrons or protons is assumed to be responsible for the isotropic cosmic x rays. It is shown that such models entail excessively high values for the intergalactic gas temperature and the photon intensity; they must therefore be rejected. (auth)

Planetary Phenomena

Refer also to abstract 7639.

7478 IS LUNAR MATTER DIFFERENT FROM TERRESTRIAL MATTER? Kondaiah, E. (Tata Inst. of Fundamental Research, Bombary). pp 167-71 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

7479 INTERNAL CONSTITUTION OF MARS. Ringwood, A. E. (Australian National Univ., Canberra); Clark, S. P. Nature (London); 234: No. 5324, 89-92(12 Nov 1971).

Hypotheses put forward to account for the low density of Mars compared with the Earth are briefly discussed, and the associated difficulties are considered. The hypothesis that maintains that Mars is composed of chondritic material in a higher state of oxidation than shown by Earth or ordinary chondritic material is investigated in more detail. This investigation was made possible by measurement of the mean radius of Mars by the Mariner experiments and by planetary radar leading to determinations of the mean density and coefficient of moment of inertia, as well as by advances in the understanding of the role of phase transformations. Models representing three different oxidation states are considered. Internal temperature distributions within Mars are estimated using chondritic U, Th, and K abundances, and density and pressure distributions are calculated for each model, the calculation proceeding inwards from the surface in steps. It was found that, in order to achieve compatibility, the models must be amended to incorporate the effects of internal differentiation, and it was concluded that a differentiated oxidised chondritic model can provide the observed density and moment of inertia. If differentiation has proceeded sufficiently to produce a core it seems likely that a crust may also be present. Such a model is also reasonable from a chemical and mineralogical point of view. It is concluded that if Mars has an oxidised chondritic composition it must be a highly differentiated body, probably possessing both a large core predominantly of HPP magnetite and a crust; this is in accordance with thermal history considerations, and if Mars has chondritic abundances of U, Th, and K, the radioactive heat generated over 4.5 billion years must have caused extensive internal melting and differentiation. The model is also consistent with the absence of a magnetic field. The relative abundances of metals are believed to be similar to those in the Sun. Predictions that might be made on the basis of the hypotheses discussed are considered. (UK)

7480 PLASMA-SHEET IONS AT LUNAR DISTANCE PRECEDING SUBSTORM ONSET. Garrett, H. B.; Hill, T. W.; Fenner, M. A. (Rice Univ., Houston, Tex.). Planet. Space Sci.; 19: No. 11, 1413-18(Nov 1971).

During the partial lunar eclipse of August 17, 1970, four intense, transient bursts of kV-energy positive ions were detected at the lunar surface by the Rice University ALSEP Suprathermal Ion Detector Experiment. The eclipse happened to occur during a main-phase geomagnetic storm while the Moon was within a few Earth radii of the calculated position of the neutral sheet. The two most intense ion bursts were each followed roughly $\frac{1}{2}$ hr later by the sudden onset of a several-thousand gamma polar magnetic substorm at the Earth's surface. Two smaller ion enhancements were also followed by smaller magnetic disturbances. This observation is interpreted in terms of a downstream escape of plasma-sheet particles associated with the substorm growth phase. (auth)

7481 RELATION OF JUPITER'S DECAMETER RADIO EMISSION TO SOLAR AND GEOMAGNETIC ACTIVITY. Kovalenko, V. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Novosibirsk, USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 3, 478-86(Nov-Dec 1971).

Translated from Astron. Zh.; 48: No. 3, 607-18(May-Jun 1971).

A one-to-one correspondence is established between the occurrence of decameter radio emission from Jupiter at 10 to 28 MHz and the shock waves responsible for the Forbush decreases in the cosmic-ray intensity, as well as high-velocity solar-wind streams crossing Jupiter's magnetosphere. It is proposed that, when shock waves and geoeffective solar-wind streams pass through Jupiter's magnetosphere, magnetic storms with various accompanying effects develop, analogous to the effects near Earth (for example, aurorae and injection of solar-wind particles into the ionosphere). Near maximum solar activity the occurrence of decameter Jovian radio emission is only weakly controlled by the satellite Io. The relation established may be applied both to clarify the nature of Jupiter's decameter radio emission and to investigate the properties of the solar wind beyond the Earth's orbit. (auth)

Atomic and Molecular Physics

Refer also to abstracts 6585, 7826, and 8227.

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 7738, 8118, and 8158.

7482 (FRNC-TH–57) CONTRIBUTION TO THE THEORETICAL STUDY OF SECONDARY ELECTRON EMISSION PRODUCED BY ELECTRON BOMBARDMENT. Cailler, Michel (Nantes Univ. (France). Faculte des Sciences). 1969. 189p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The various terms related to the phenomenon of secondary electron emission (SEE) are defined. The principal experimental results recently obtained are reviewed. The possibility of relating the yield-against-primary-energy curves to the range of the primary electrons and also to the depth of release of the secondary electrons is considered. Such an interpretation is shown to be consistent with the effect of the incidence angle on the SEE coefficients and the location of the maximum of these coefficients. A proof of Palmberg's interpretation of the fine structure due to changes in the angle of incidence with a single crystal is given. The collective modes are demonstrated to be important in the case of normal metals. The band transitions from α levels are dominant when the levels are sufficiently near the Fermi surface, this being the case for transition and noble metals. The quantum theory given is restricted to metals; calculations are made for Al and the noble metals. Experiment and theory are in very good agreement in the case of Cu. (France)

7483 (FRNC-TH–62) POLARIZED ELECTRON BEAMS. STUDY AND DEVELOPMENT OF A SOURCE USING THE PHOTON IONIZATION OF AN ORIENTED ATOMIC BEAM. Coiffet, Philippe (Paris Univ., Orsay (France). Faculte des Sciences). 1970. 102p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The aim of this experiment was to design a very intense source of polarized free electrons. A beam of K atoms emitted from an oven at a temperature between 200°C and 350°C was passed through a strongly inhomogeneous magnetic field. The atoms with $+\frac{1}{2}$ spin, focused at the exit of the magnet, were thus separated from the atoms with $-\frac{1}{2}$ spin, which were unfocused. The $+\frac{1}{2}$-spin atoms obtained were selected by a convenient diaphragm, kept in the longitudinal magnetic field, and ionized by uv radiation. As the ionization was performed without transitions, the electrons produced were polarized. They were then accelerated. Their longitudinal polarization was transformed into a transverse polarization by means of a particular field configuration, called a field transformer. The polarization was analyzed by Mott scattering with Au foil. Theoretically, the polarization may reach that of the atomic beam, that is 90%. The source of polarized electrons thus developed can supply a dc current of more than two picoamperes with a polarization of 70%. (France)

7484 (LRP–49/71) STRUCTURE OF PULSED MOLECULAR HYDROGEN AND CONDENSED NITROGEN BEAMS. **Keller, R. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)). Oct 1971. 33p. (In French). Dep. NTIS (U. S. Sales Only).**

High-intensity molecular hydrogen beams and condensed nitrogen beams were obtained using a cooled, pulsed Laval nozzle. The collimated beams, which have sharp profiles, are considered suitable for plasma injection experiments. (auth)

7485 PHENOMENA OCCURRING DURING THE BOMBARDMENT OF A THIN METALLIC FOIL WITHOUT ANY SUBSTRATE WITH A HIGH ENERGY MOLECULAR JET. **Devienne, Marcel; Lanteri, Henri (Univ., Nice). Compt. Rend., Ser. B; 273: No. 9, 333-4(30 Aug 1971). (In French).**

Thin foils were produced without substrates from calibrated ribbons by sputtering, using a jet of molecular argon having an energy of 10 keV. A foil of some thousand Å can be obtained in 30 to 70 min from a calibrated 1-μ gold foil. The secondary electron emission current decreases with decreasing foil thickness. However, at the back of the thin foil, ionic and electronic emission, increasing with decreasing foil thickness, takes place. (France)

7486 RARE GAS SCATTERING FROM LiF. III. MULTILOBULAR STRUCTURE FOR NEON. **O'Keefe, D. R.; Palmer, R. L.; Smith, Joe N. Jr. (Gulf Energy and Environmental Systems Co., San Diego, Calif.). J. Chem. Phys.; 55: No. 9, 4572-7(1 Nov 1971).**

Additional data to that previously reported for the scattering of Ne from the (001) surface of LiF are presented and compared with the results of a recent theoretical analysis. The data presented include details of the in-plane scattering for the case in which the plane of incidence intersects the surface in the ⟨110⟩ azimuth as well as a detailed examination of the out-of-plane scattering for the case in which the plane of incidence lies along both the ⟨010⟩ and ⟨110⟩ azimuthal directions. Measurements are made as a function of angle of incidence, beam temperature, and surface temperature. A complex multilobate structure is observed and, in those instances in which a direct comparison with the theory is available, very good agreement is obtained. (auth)

7487 PHOTON EMISSION FROM SPUTTERED PARTICLES DURING ION BOMBARDMENT. **Tsong, I. S. T. (Univ. of Essex, Colchester, Eng.). Phys. Status Solidi (a); 7: No. 2, 451-8(16 Oct 1971).**

The emission of photons when the surfaces of metals, semiconductors, ionic crystals, and glasses are bombarded by 5- to 8-keV argon ions was studied by spectroscopic analysis. Conditions for the resonance transfer of an electron between a metal and an ionized or excited atom at small distances from the surface were examined and applied to the sputtered particles of the various materials. It was established that these conditions govern the light emission from the low-energy sputtered particles of metals and are also, to some extent, applicable to semiconductors. For insulators, however, the radiation appears to come only from excited sputtered atoms. (auth)

7488 ANGULAR DEPENDENCE OF PAIR ANNIHILATION RADIATION. **Biswas, M.; Roy, S. C.; Ghose, A. M. (Bose Inst., Calcutta). pp 483-7 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).**

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

7489 ENERGY-LOSS SPECTRA OF INELASTICALLY SCATTERED ELECTRONS FROM TUNGSTEN. **Edwards, David Jr.; Propst, F. M. (Univ. of Illinois, Urbana). J. Chem. Phys.; 55: No. 11, 5175-8(1 Dec 1971).**

The energy-loss spectra of electrons scattered from a W(100) surface were measured on both clean and gas-covered (H_2, N_2, H_2O, O_2, CO) surfaces. Two additional peaks were observed in the spectra from the clean surface and a 7.5-eV peak was observed upon H_2O adsorption. (auth)

7490 SPUTTERING OF NIOBIUM BY NIOBIUM, HYDROGEN, DEUTERIUM, AND HELIUM IONS IN THE 10- TO 80-keV ENERGY RANGE. **Summers, A. J.; Freeman, N. J.; Daly, N. R. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Appl. Phys.; 42: No. 12, 4774-8(Nov 1971).**

Sputtering coefficients of niobium for bombardment by Nb, H, D, and He ions in the 10- to 80-keV range have been measured and compared with theory. The light-ion measurements were obtained by sputtering through a thin film (600 Å) of niobium deposited on a zirconium substrate. Penetration of the film was observed by the appearance of substrate ions in the mass spectrum of sputtered ions from the target. (auth)

7491 CUMULATIVE IONIZATION IN OPTICALLY PUMPED HELIUM DISCHARGES: A SOURCE OF POLARIZED ELECTRONS. **McCusker, M. V.; Hatfield, L. L.; Walters, G. K. (Rice Univ., Houston, Tex.). Phys. Rev., A; 5: No. 1, 177-89(Jan 1972).**

Polarization analysis of electrons extracted from a weak helium discharge in which the $2\ {}^3S_1$ metastable atoms are spin-oriented by optical pumping indicates that the reaction $He(2\ {}^3S_1) + He(2\ {}^3S_1) \rightarrow He(1\ {}^1S_0) + He^+ + e^-$ is the predominant source of ionization in the discharge. The reaction conserves spin angular momentum and therefore produces polarized electrons. The process has been exploited to produce continuous beams of electrons with polarization as high as 10%. For a source-gas pressure of 0.035 torr, a continuous 4-μA beam with 8% spin polarization was realized. Electrons extracted from the late afterglow of a pulsed discharge have 17% polarization at an optimum pressure of 0.1 torr. (auth)

7492 POLARIZED ELECTRONS FROM PHOTOIONIZATION OF POLARIZED ALKALI ATOMS. **Hughes, V. W.; Long, R. L. Jr.; Lubell, M. S.; Posner, M.; Raith, W. (Yale Univ., New Haven). Phys. Rev., A; 5: No. 1, 195-222(Jan 1972).**

The process of photoionization of polarized alkali metal atoms in an atomic beam was studied for potassium and lithium. Depolarization processes associated with photoionization of alkali metal molecules and optically excited atoms were discovered. After eliminating these depolarization mechanisms, the measured photoelectron polarization agreed within an accuracy of 3% with the predicted polarization based on the current theory for this electric dipole process. Using a polarized ^6Li atomic beam and a pulsed uv light source, an intense and highly polarized electron beam with 2×10^8 electrons in 1.5 μsec and with a polarization of 0.78 was produced, which is a suitable prototype injector source for a high-energy electron accelerator. (auth)

Atomic and Molecular Properties

Refer also to abstracts 7561, 7736, 7737, 7743, 7758, and 7759.

7493 ELECTRIC, MAGNETIC, AND SPECTRAL PROPERTIES OF H_3^+ GROUND STATE CALCULATED FROM SINGLE-CENTER WAVE FUNCTIONS. Kawaoka, Kenji; Borkman, Raymond F. (Georgia Inst. of Tech., Atlanta). J. Chem. Phys.; 55: No. 9, 4637-41(1 Nov 1971).

Single-center wave functions, employing up to 100 configuration-interaction terms, are used to compute electric, magnetic, and spectral properties of the $^1A_1'$ electronic ground state of equilateral triangular H_3^+. The best values for several computed properties are: electronic energy, $E = -1.3405$ hartree; equilibrium internuclear distance, $R = 1.65$ bohr; electric quadrupole moment, $\Theta_{zz} = -1.2540$ B ($B = 10^{-26}$ esu · cm^2); and Larmor contribution to the mean diamagnetic susceptibility, $\chi_L = -3.2693 \times 10^{-6}$ cgs · emu. Expectation values for the squared electronic coordinate operators $\langle x_1^2 \rangle$, $\langle y_1^2 \rangle$, $\langle z_1^2 \rangle$, and $\langle r_1^2 \rangle$ are also given. The derivative of the electric quadrupole moment with respect to symmetric motion of the nuclei was calculated to be $\partial\Theta_{zz}/\partial R = -2.5531$ B/Å, while the derivative of the electric dipole moment (center-of-mass origin) with respect to molecular bending was calculated to be $\partial\mu_x/\partial\phi = -0.0193$ D/deg. These latter results permit prediction of the strengths of the quadrupole-allowed A_1' and dipole-allowed E' vibrational fundamentals in the infrared spectrum. Finally, using excited-state wave functions and oscillator strengths reported previously, the components of the electric dipole polarizability for the $^1A_1'$ state were calculated to be $\alpha_{xx} = \alpha_{yy} = 0.4879$ Å^3, $\alpha_{zz} = 0.2567$ Å^3, $\overline{\alpha} = 0.4109$ Å^3. (auth)

7494 UPPER AND LOWER BOUNDS ON STATIC POLARIZABILITY. **Tang, K. T. (Pacific Lutheran Univ., Tacoma). J. Chem. Phys.; 55: No. 10, 5139-40(15 Nov 1971).**

Formulas are proposed for calculation of upper and lower bounds for static polarizability of atoms or molecules from refractivity measurements. Results for the He atom are presented as an example. (A.G.W.)

7495 USE OF THE NONSYMMETRICAL WAVE FUNCTION. II. DYNAMIC POLARIZABILITY OF MOLECULAR HYDROGEN. Ando, Toshihiko; Saika, A. (Kyoto Univ.). J. Chem. Phys.; 55: No. 9, 4203-7(1 Nov 1971).

The nonsymmetrical (NS) wave function is employed to calculate the real- and imaginary-frequency dynamic polarizabilities of the hydrogen molecule, and double perturbation theory allows one to calculate them through first order in electron correlation within the same theoretical framework. From the imaginary-frequency polarizability, the London coefficients for the dispersion interactions of H_2-H_2 and $H-H_2$ are also obtained. The results in the shielding and geometric approximations are compared with other theoretical and experimental values, and it is found that the use of the NS wave function can be extended to time-dependent problems with reasonable accuracy and much ease of computation. (auth)

7496 ABSORPTION COEFFICIENTS OF HELIUM BETWEEN 599 AND 610 Å; TRANSITION MOMENT FOR He_2 $A^1\Sigma_u^+ \leftarrow X^1\Sigma_g^+$. Chow, K. W.; Smith, Allan Laslett; Waggoner, M. G. (Yale Univ.). J. Chem. Phys.; 55: No. 9, 4208-13(1 Nov 1971).

Absorption coefficients of helium were measured in the region of the continuum–bound transition $A^1\Sigma_u^+ \leftarrow X^1\Sigma_g^+$ of He_2 (599 to 610 Å) for temperatures of 77, 200, and 298°K. The absorption coefficient k is proportional to the square of the helium density n^2. The quantity k/n^2, ranging between 10^{-39} and 10^{-42} cm^5, is in excellent agreement with the continuum–bound absorption coefficients of He_2 A ← X calculated by Sando and Dalgarno, supporting a value of 0.20 a.u. for the electronic transition moment of He_2 A ← X between 2 and 3 Å. (auth)

7497 SEARCH FOR THE H_3^{2+} ION. Berkowitz, E. H.; Stocker, H. (Univ. of Notre Dame, Indiana). J. Chem. Phys.; 55: No. 9, 4606-7(1 Nov 1971).

Charge stripping of H_3^+ and D_3^+ at 3 to 4 MeV was used to search for H_3^{2+} and D_3^{2+}. Analyses by several means, including a search for nuclear reactions induced by the constituent nuclei, give no evidence for a stable doubly charged triatomic hydrogen molecule. (auth)

7498 CORRELATION STUDIES ON H_3^+. I. THE WAVE FUNCTIONS. Duben, Anthony J.; Lowe, John P. (Pennsylvania State Univ., University Park). J. Chem. Phys.; 55: No. 9, 4270-5(1 Nov 1971).

Four configuration-interaction calculations on the D_{3h} H_3^+ molecular ion are reported. Two Gaussian lobe basis sets are used, and calculations are made with only doubly substituted configurations and also with both doubly and singly substituted configurations. The best calculation gives an energy of −1.34050 hartree at a fixed internuclear distance of 1.6406 bohr. The wave functions are analyzed in terms of natural orbitals and compared with each other and with some wave functions from the literature. (auth)

7499 CORRELATION STUDIES ON H_3^+. II. ELECTRON DENSITIES AND EXPECTATION VALUES. Duben, Anthony J.; Lowe, John P. (Pennsylvania State Univ., University Park). J. Chem. Phys.; 55: No. 9, 4276-82(1 Nov 1971).

Effects of correlation on one-electron distribution and other properties are calculated for the H_3^+ molecular ion. Effects due to singly substituted and doubly substituted configurations are essentially additive for this closed-shell species. The effect of doubly substituted configurations is to shift charge from the molecular center to nuclear regions, mainly outside the molecule. This is rationalized in terms of the many-electron theory of Sinanoğlu. The singly substituted configurations cause a slight electronic contraction similar to that caused by initial atomic–molecular formation. Neglect of singly substituted configurations is not justified when one is seeking improvement of properties beyond the Hartree–Fock self-consistent-field level. (auth)

7500 CONTINUITY AT THE DISSOCIATION THRESHOLD IN MOLECULAR ABSORPTION. Allison, A. C.; Dalgarno, A. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). J. Chem. Phys.; 55: No. 9, 4342-4(1 Nov 1971).

A continuity relationship is established for molecules that relates discrete absorption oscillator strengths to photodissociation cross sections. The relationship is verified by explicit numerical calculations on H_2 and O_2. (auth)

7501 SYMMETRY-ADAPTED PERTURBATION THEORIES: APPLICATION TO A GENERALIZED EIGENVALUE EQUATION FOR THE HYDROGEN MOLECULAR ION. Laughlin, C. (Smithsonian Astrophysical Observatory, Cambridge, Mass.); Amos, A. T. J. Chem. Phys.; 55: No. 10, 4837-42(15 Nov 1971).

Analogs of the Murrell–Shaw, Musher–Amos, and van der Avoid–Hirschfelder symmetry-adapted perturbation theories are devised for the case of a generalized eigenvalue equation. The new procedures are applied to the hydrogen molecule ion, and perturbation energies through second order are calculated at various internuclear distances. (auth)

7502 LONG-RANGE RETARDED INTERACTION BETWEEN TWO HYDROGEN ATOMS. Deal, W. J.; Young, R. H. (Univ. of California, Riverside). Chem. Phys. Lett.; 11: No. 3, 385-6(15 Oct 1971).

The leading term in the long-range relativistic interaction energy of two nondegenerate atoms is expressed in terms of functions appearing in the calculation of dynamic polarizabilities. This term is found in closed form for two 1 s hydrogen atoms. (auth)

7503 EXACT SOLUTION OF THE HYDROGEN SPECTRAL LINE BROADENING PROBLEM IN ONE-ELECTRON THEORY. Lisitsa, V. S.; Sholin, G. V. Zh. Eksp. Teor. Fiz.; 61: No. 3, 912-21(Sep 1971). (In Russian).

A general theory of Stark broadening of hydrogen spectral lines, which does not involve any restriction inherent in the impact or quasi-static approaches, is developed within the framework of the one-electron (binary) approximation. The theory is based on an exact solution of the dynamic problem of behavior of an emitting hydrogen atom in the field of a moving charged particle. The properties of four-dimensional symmetry of the hydrogen atom are employed to solve the problem. A general analytic expression for the complete line contour is obtained; in the extreme cases of small and large frequency shifts the expression includes the results of the impact and quasi-static theories, respectively. An important feature of the solution is that it yields an analytic description of the intermediate frequency region. Another merit of the approach is that it remains as graphic as the simple qualitative broadening models. (auth)

7504 SINGLE-CONFIGURATION WAVE FUNCTIONS AND POTENTIAL CURVES FOR LOW-LYING STATES OF He_2^+, Ne_2^+, Ar_2^+, F_2^-, Cl_2^- AND THE GROUND STATE OF Cl_2. Gilbert, T. L.; Wahl, Arnold C. (Argonne National Lab., Ill.). J. Chem. Phys.; 55: No. 11, 5247-61(1 Dec 1971).

Wave functions, orbital energies, and potential curves for He_2^+, Ne_2^+, Ar_2^+, F_2^-, and Cl_2^- were calculated in the molecular-orbital self-consistent-field approximation over a range $R_e \lesssim R < \infty$ for the ground state and those excited states that dissociate into an atom and an ion in their ground states. The ground-state potential curve of Cl_2 was calculated for $R \sim R_e$. Dissociation energies and other parameters obtained from the calculated potential curves are compared with corresponding parameters obtained from elastic differential scattering measurements and resonant electron capture in noble gases, measurements of afterglow line profiles in dissociative recombination radiation in neon and argon, optical absorption spectra of V_K centers, and endoergic charge-transfer studies of halogen ions and molecules. A formal analysis and discussion of the sources of correlation error in the calculated potential curves and a discussion of the expansion errors are also given. (auth)

7505 STUDY OF DIFFERENT APPROXIMATION IN THE CALCULATION OF g TENSORS: H_2^+. de Montgolfier, Ph.; Harriman, John E. (Univ. of Wisconsin, Madison). J. Chem. Phys.; 55: No. 11, 5262-9(1 Dec 1971).

The theory of the g tensor in one-electron systems is briefly reviewed and calculations are done in several ways for the H_2^+ molecular ion in order to test approximations that must be made for larger systems. Approximate ground-state wave functions are determined variationally using a power series in elliptic coordinates and as a linear combination of atomic orbitals. The first-order wave function with respect to the orbit-field perturbation is calculated variationally and by a Rayleigh–Schrödinger expansion and the second-order g tensor determined. Excited-state functions and energies are approximated from the higher roots of the secular equations involved. The results of the various approximate calculations are compared and discussed. It is found that the LCAO method is rather poor and that two-center integrals cannot be neglected. It also appears that a single spin–orbit parameter cannot be used for different orbitals on the same atom. The best result, obtained from the variationally determined first-order function, has g_{xx} differing from the free electron value by -0.225×10^{-5}. (auth)

7506 LONG-RANGE INTERACTION BETWEEN METASTABLE HELIUM AND GROUND-STATE HELIUM. Victor, G. A. (Smithsonian Astrophysical Observatory, Cambridge, Mass.); Sando, K. J. Chem. Phys.; 55: No. 11, 5421-2(1 Dec 1971).

An expression obtained by carrying out the conventional second-order perturbation theory is given for the second-order energy. Evaluation of the expression results in a value of $-(41.8 \pm 2.9)\ R^{-6}$ a.u. (A.G.W.)

7507 MEAN-LIFE MEASUREMENTS IN He I BY THE HANLE EFFECT ON HIGH-VELOCITY ATOMS EXCITED IN A GASEOUS TARGET. Carre, M.; Desesquelles, J.; Dufay, M.; Gaillard, M. L. (Univ., Lyon). Phys. Rev. Lett.; 27: No. 21, 1407-9(22 Nov 1971).

Mean lives of He I are deduced from the Hanle curves for high-velocity atoms excited in a gaseous target. For long-mean-life levels oscillations in agreement with a partial precession of the dipoles around the magnetic field were observed. For the 3p ^1P level, the Hanle curve is not perturbed by self-absorption using this method, and the measured mean life (1.8 ± 0.1 nsec) is in good agreement with the theoretical value. (auth)

7508 L_2 AND L_3 SUBSHELL FLUORESCENCE AND COSTER–KRONIG YIELDS FOR Z = 96 FROM THE DECAY OF ^{249}Cf. McGeorge, J. C.; Fink, R. W. (Georgia Inst. of Tech., Atlanta). Z. Phys.; 248: No. 3, 208-19(1971).

The L_2 and L_3 subshell fluorescence and Coster–Kronig yields for Z = 96 have been measured by the K–L x-ray coincidence method with high resolution Si(Li) and Ge(Li) x-ray detectors. The results $\nu_2 = 0.650 \pm 0.036$, $\omega_2 = 0.552 \pm 0.032$, $\omega_3 = 0.515 \pm 0.034$, and $f_{23} = 0.188 \pm 0.019$ agree fairly well with theory. New measurements of the L x-ray single spectra of ^{244}Cm and ^{238}Pu with a high resolution Si(Li) detector permitted reevaluation of the values of ω_2 and f_{23} for Z = 92 and 94 reported by Byrne et al. The revised values at Z = 92 are $\omega_2 = 0.529 \pm 0.035$ and $f_{23} = 0.23 \pm 0.12$, and Z = 94, $\omega_2 = 0.523 \pm 0.023$ and $f_{23} = 0.24 \pm 0.08$. These revised values are in much better agreement with theory and with current experiments. (auth)

7509 HYPERPOLARIZABILITIES FOR HARTREE–FOCK ATOMS. Sitter, R. E. Jr. (Gannon Coll., Erie, Pa.); Hurst, R. P. Phys. Rev., A; 5: No. 1, 5-11(Jan 1972).

A fully coupled Hartree–Fock variational method is used to calculate the hyperpolarizability of the He, Be, Ne, and Ar atoms. In these calculations the hyperpolarizability is inferred from the electric moment induced in the atoms for various finite values of the external static electric field. A formulation of the problem and the justification for the methods used are given. The nonlinear parameters of all the wave functions used in these calculations are presented along with a convergence test for the wave function of the helium atom. The nuclear dipole shielding factor, polarizability, and hyperpolarizability are tabulated for these atoms, and the results are discussed and compared with previous theoretical and experimental results. (auth)

7510 EIGENVALUES OF THE $2p3p^3P$ AND $2p3d^{1,3}D$ BOUND STATES OF THE HELIUM ISOELECTRONIC SEQUENCE. Doyle, H.; Oppenheimer, M. (Harvard Coll. Observatory, Cambridge, Mass.). Phys. Rev., A; 5: No. 1, 26-9(Jan 1972).

The 1/Z expansion method is used to calculate the eigenvalues of the $2p3p^3P$ and $2p3d^{1,3}D$ states of the helium isoelectronic sequence. The results are compared to variational calculations for neutral helium. Wavelengths are predicted for a number of transitions originating in doubly excited states of the helium-like ions up to Fe xxv. The results for neutral helium are compared to recent beam–foil experiments, and alternative line identifications are made. The predicted wavelength for the $2p3d^3D-2p^{2,3}P$ transition is 3014 Å, in close agreement with the line observed by Berry et al., at 3012 ± 2 Å. (auth)

7511 ELECTRON BINDING ENERGIES, X-RAY SPECTRA, AND L-SHELL FLUORESCENCE YIELDS IN CURIUM (Z equals 96). Chu, Y. Y. (Brookhaven National Lab., Upton, N. Y.); Perlman, M. L.; Dittner, P. F.; Bemis, C. E. Jr. Phys. Rev., A; 5: No. 1, 67-72(Jan 1972).

The Cm K x-ray spectrum from the decay of ^{249}Cf and the Cm L x-ray, internal-conversion, and γ-ray spectra associated with the 42.9-keV E2 transition in the α decay of ^{250}Cf were measured at high resolution. From these data accurate values for the binding energies of K, L_1, L_2, L_3, M_1, M_2, M_3, M_4, M_5, N_1, N_2, N_3, N_4, N_5, O_2, O_3, O_4, and P_3 electrons in Cm were obtained. Values were derived also for the L-subshell fluorescence yields in Cm: $\omega_1 = 0.28 \pm 0.06$, $\omega_2 = 0.55 \pm 0.02$, and $\omega_3 = 0.63 \pm 0.02$. (auth)

7512 ELECTRIC FIELD DEPENDENCE OF THE ATOMIC-HYDROGEN HYPERFINE SEPARATION. Gibbons, P. C.; Ramsey, N. F. (Harvard Univ., Cambridge, Mass.). Phys. Rev., A; 5: No. 1, 73-8(Jan 1972).

The Stark shift of the atomic-hydrogen hyperfine separation was measured in a hydrogen maser designed to study in particular the dependence of the shift on the angle θ between the external electric and magnetic fields. A method of designing shielded solenoids to produce arbitrary magnetic fields is presented. The result of the experiment is $\delta\nu_{\text{Stark}} = (-7.1 \pm 1.1) \times 10^{-5}E^2$ $(\theta = 0)$ using electrostatic units for the electric field E, and $[\delta\nu_{\text{Stark}}(\theta = 0) - \delta\nu_{\text{Stark}}(\theta = \pi/2)]/[\delta\nu_{\text{Stark}}(\theta = 0)] = -1\% \pm 10\%$. (auth)

7513 ELECTRIC FIELD QUENCHING OF METASTABLE 2^1S_0 HELIUM. Petrasso, R.; Ramsey, A. T. (Brandeis, Univ., Waltham, Mass.). Phys. Rev., A; 5: No. 1, 79-83(Jan 1972).

The transition rate of the normally metastable helium 2^1S_0 state in the presence of a uniform electric field was measured by observing the attenuation of a metastable beam of helium passing between parallel electric field plates. This attenuation, when combined with measurement of the velocity distribution of the beam, yields a transition rate of $(0.926 \pm 0.020)F^2\ \text{sec}^{-1}$, where F is the field strength in kV/cm. This agrees well with the calculated value of $(0.920 \pm 0.030)F^2\ \text{sec}^{-1}$, which is derived from a sum of oscillator strengths published by various workers. (auth)

7514 POLARIZATION OF QUENCH-INDUCED LYMAN-α RADIATION. Wooten, J. W.; Macek, J. H. (Univ. of Nebraska, Lincoln). Phys. Rev., A; 5: No. 1, 137-40(Jan 1972).

The polarization of quench-induced L_α radiation is calculated for a metastable hydrogen atom entering an electric field with entry conditions intermediate between adiabatic and impulsive. It is found that for most common experimental geometries the adiabatic value for the polarization may be used with less than 10% error. (auth)

7515 DISCREPANCY BETWEEN THEORY AND EXPERIMENT FOR THE COMPTON PROFILE OF MOLECULAR HYDROGEN. Brown, Richard Edwin; Smith, Vedene H. Jr. (Queen's Univ., Kingston, Ont.). Phys. Rev., A; 5: No. 1, 140-3(Jan 1972).

The Compton profile of the ground state of molecular hydrogen is calculated using the Liu 39-configuration-interaction (CI) wave function to confirm the experimental results of Eisenberger. This is in contrast to previous theoretical results obtained with the Hartree–Fock and Das–Wahl CI wave functions. The merits of these wave functions and also the best-overlap wave function are discussed. (auth)

7516 TEMPERATURE DEPENDENCE OF THE LAMB SHIFT. Barton, G. (Univ. of Sussex, Brighton, Eng.). Phys. Rev., A; 5: No. 1, 468-70(Jan 1972).

The temperature-dependent correction to the Lamb shift of a single-electron atom exposed to black-body radiation at temperature T is considered. At room temperatures, the correction for Z > 1 is dominated by a shift, not considered before, of the $2s_{1/2}$ level, involving $2p_{1/2}$ as an intermediate state, and is given by $\pi\alpha^3 Z^2 (kT)^2/8m$. This competes with another shift $\approx x(kT)^4/Z^4(\alpha m)^3$ discussed by Walsh, where x is a purely numerical but remarkably large coefficient of order 300. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

7517 (RISO-M–1400) LEAST-SQUARES FITTING PROGRAMME POSITRONFIT: PRINCIPLES AND FORMULAS. Kirkegaard, P.; Eldrup, M. (Danish Atomic Energy Commission, Risoe. Research Establishment). Sep 1971. 15p. Dep. NTIS (U. S. Sales Only).

A computer program is described that analyzes positron lifetime spectra by a least-squares technique of the semilinear Marquardt type. The model includes up to four lifetimes. Fixed values can be imposed on any number of lifetimes and relative intensities. Correction for the source annihilation can be made. The results include the variance–covariance matrix of the fitted parameters. (auth) (Denmark)

7518 2s ATOMIC LEVEL IN MUONIC ^{208}Pb. Jenkins, D. A. (Virginia Polytechnic Inst., Blacksburg); Powers, R. J.; Martin, P.; Miller, G. H.; Welsh, R. E. Nucl. Phys.; A175: No. 1, 73-100(1971).

The measurement of the energies and the relative intensities of various muonic atomic transitions above 500 keV in ^{208}Pb including transitions to and from the 2s level is reported. Besides the usual E1 transitions 3d → 1s and 4d → 2p E2 transitions were observed. Interpretation of these data in terms of various charge distributions is made. Appreciably better fits are obtained by assuming the presence of nuclear polarization and allowing the nuclear polarization parameters $\Delta E(1s)$ and $\Delta E(2s)$ of the 1s and 2s levels to vary. Least-squares fits indicate values of $\Delta E(1s) =$

−8.9 ± 2.7 keV and ΔE(2s) = −0.6 ± 0.7 keV. Comparisons with electron scattering results are made. (auth)

7519 PARAPOSITRONIUM LIFETIME. Patro, A. P.; Sen, P. (Saha Inst. of Nuclear Physics, Calcutta). J. Phys., A (London); 4: No. 6, 856-8(Nov 1971).

The parapositronium lifetime was measured in toluene and fused quartz samples in a time distribution measurement experiment. The lifetime and intensity of the parapositronium components are τ_0 (0.115 ± 0.015) nsec with I_0 (15 ± 6)% for toluene and τ_0 (0.126 ± 0.010) nsec with I_0 (14 ± 6)% for fused quartz. (auth)

7520 MEASUREMENT OF KAONIC X RAYS FROM ^{4}He. Wiegand, Clyde E.; Pehl, Richard H. (Univ. of California, Berkeley). Phys. Rev. Lett.; 27: No. 21, 1410-12(22 Nov 1971).

Three spectral lines corresponding to Bohr orbit transitions $n = 3 \rightarrow 2$, $n = 4 \rightarrow 2$, and $n = 5 \rightarrow 2$ in liquid ^{4}He were measured with a resolution of 340 eV. Intensities per stopped kaon were 0.09, 0.05, and 0.02, respectively. No evidence was seen for transitions to $n = 1$ (intensity <0.004). (auth)

7521 PROBABILITY OF FORMATION OF Σ HYPERONIC ATOMS IN VARIOUS ELEMENTS. Zieminska, Daria (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett.; 37B: No. 4, 403-4(13 Dec 1971).

The probability that a Σ hyperonic atom is formed when a K^- meson is stopped in a target is calculated. It is found that this probability in heavy elements is about one half that for light ones. (auth)

Collision Phenomena

Refer also to abstract 7659.

7522 (FRNC-TH-44) EXPERIMENTAL DETERMINATION OF THE IONIZATION CROSS SECTIONS OF SOME RARE GASES NEAR THE THRESHOLD. Doritch, Michel (Rennes Univ. (France). Faculte des Sciences). 1970. 92p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The cross sections for ionization of some rare gases (He, Ar, Ne) by electron impact were determined experimentally. Near the threshold, some definite experimental conditions were imposed: the energy dispersion of the incoming electrons was reduced by using an electrostatic selector; the electrons were focused on the collector to prevent them from hitting the walls of the collision chamber; the ions formed were identified using a mass spectrometer and the counting method used enabled a good determination of the weak variations in the ion current to be achieved. The absolute measurements performed with electrons of about 20 eV above the threshold were thus extended down to the threshold with an efficiency greater than that obtained with a Tate and Smith apparatus. Multiple ionization was not considered. The relative cross sections were determined, and the absolute cross sections were then derived from Rapp and Englander—Golden results extrapolated to low energies, Rapp's results being considered till now as the more precise (better than 10%). (France)

7523 (UCRL-20426, pp 176-204) ATOMIC AND MOLECULAR SPECTROSCOPY. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1971.

From Nuclear chemistry.

Most of the brief summaries of this section were taken from or condensed from published literature or UCRL reports. In only two cases was this not true: (1) alignment ^{7}Li atoms formed by charge-capture collisions with crossed atomic beams and carbon foils, and (2) ab initio calculations of the electronic structure of small molecules. (L.M.T.)

7524 CROSS SECTIONS FOR CAPTURE OF LOW-ENERGY ELECTRONS IN H_2O VAPOR. Melton, Charles E.; Neece, George A. (Univ. of Georgia, Athens). J. Chem. Phys.; 55: No. 9, 4665-6(1 Nov 1971).

A mass spectrometer was designed, constructed, and used to measure cross sections and appearance potentials for the production of H^- and O^- from H_2O by electron impact. The results are tabulated. (A.G.W.)

7525 ANGULAR DISTRIBUTION OF THE PHOTOELECTRON SPECTRA FOR Ar, Kr, Xe, H_2, N_2, AND CO. Carlson, Thomas A.; Jonas, A. E. (Oak Ridge National Lab., Tenn.). J. Chem. Phys.; 55: No. 10, 4913-24(15 Nov 1971).

The distribution of photoelectrons as a function of the angle θ between the direction of the incoming photon and outgoing photoelectron was measured for Ar, Kr, Xe, H_2, N_2, and CO. The experiments were carried out with a double-focusing electrostatic electron spectrometer to which was attached a chamber containing a gas discharge lamp that can be freely rotated. The He I (584 Å) and Ne I (736, 744 Å) resonance lines were used as photon sources. For each of the photoionization bands studied the angular distribution could be fitted to the general shape predicted from theory: $1 + \beta/2\ (3/2 \sin^2\theta - 1)$. In addition, the values of the parameter β experimentally determined were in good agreement with theoretically determined values for H_2 and for the rare gases but only partially satisfactory agreement for the first ionization potential of N_2. The Π states of N_2^+ and CO^+ give lower values of β than the Σ state according to expectations. In general the vibrational structure for a given band was independent of θ, but several exceptions were found for both N_2 and CO, which have been discussed in terms of the presence of autoionization states and possible breakdown in the Born—Oppenheimer approximation. (auth)

7526 CALCULATION OF COLLISIONAL DISSOCIATION OF ALKALI HALIDE MOLECULES BY CLASSICAL ONE-DIMENSIONAL MODELS. Fan, Hsiang (Univ. of Chicago). J. Chem. Phys.; 55: No. 9, 4628-32(1 Nov 1971).

Classical one-dimensional calculations were carried out to estimate the rate of dissociation of CsBr by collisions with Xe, as a function of collision energy and vibrational energy. Three models were used: a truncated harmonic oscillator for CsBr with impulsive collisions with Xe, a Rittner-type ionic potential for CsBr with impulsive collisions with Xe, and a Rittner-type potential for CsBr with a soft (12-4-6) potential representing collisions with Xe. Results are in qualitative agreement with the experimental findings of Tully et al., but poor quantitative agreement implies that the problem requires a three-dimensional treatment for proper description, and, near threshold, probably inclusion of charge exchange in the potential. The calculations show very clearly how kinematic constraints prevent collisions near threshold energy from dissociating molecules that have little or no vibrational energy. The dependence of the dissociation probability on the vibrational temperature is also discussed. It is shown that, in some cases, a negative temperature dependence may arise. (auth)

7527 SEMICLASSICAL THEORY OF VIBRATIONALLY INELASTIC SCATTERING IN THREE DIMENSIONS. Wartell, M. A.; Cross, R. J. Jr. (Yale Univ., New Haven). J. Chem. Phys.; 55: No. 10, 4983-91(15 Nov 1971).

A hierarchy of semiclassical approximations is derived to treat vibrationally inelastic scattering in three dimensions. The radial wave functions of the coupled Schrödinger equations for the combined vibrationally and rotationally inelastic scattering are expressed in terms of the radial wave functions for elastic scattering from a spherically symmetric potential to "remove" the elastic scattering from the problem. The rotationally inelastic scattering is diagonalized using the sudden approximation. The orbital angular momentum is diagonalized using a classical action-angle transformation. The result is a simple set of coupled differential equations—one for each vibrational state. For small changes in relative energy the coupled equations are obtained for a time-dependent perturbation acting along a single classical trajectory. If the energy changes can be neglected, the sudden approximation for the vibrationally inelastic scattering is obtained. For large changes in energy a multitrajectory method is developed, which uses a separate trajectory for each vibrational state. Using the sudden approximation, vibrationally inelastic transition probabilities are calculated for He + H_2 as a function of molecular orientations and impact parameters. Orientation-averaged cross sections cannot be obtained from collinear trajectories by a simple steric factor independent of energy and the specific transition. It is also shown that, in the sudden limit, the orientation-averaged differential cross section is approximately equal to the differential cross section for the orientation-averaged potential. (auth)

7528 CALCULATION OF THE WIDTH OF NARROW SHAPE RESONANCES. Bain, R. A.; Bardsley, J. N. (Univ. of Pittsburgh). J. Chem. Phys.; 55: No. 9, 4535(1 Nov 1971).

A quantum technique is described for the calculation of the energy and width of shape resonances. It appears to be the only such method applicable to resonances with very long lifetimes. Results for a Lennard-Jones potential are presented and compared with previous quantum and semiclassical calculations. (auth)

7529 COLLISIONS OF N_2^+ IONS ON NOBLE GAS ATOMS. I. COLLISION INDUCED DISSOCIATION OF N_2^+. Fournier, P. (Paris Univ., Orsay, France); Durup, J.; Pernot, A. J. Phys. (Paris); 32: No. 7, 533-41(Jul 1971).

The dissociation of 0.35- to 4.4-keV N_2^+ ions after collisions with He or Xe targets was studied using two different apparatus. Measurements on the velocity distributions of the N^+ fragments, using various-energy electrons to produce the parent N_2^+ ions, revealed seven different processes; the internal energies of the ion and the target in the initial and final states were determined for most of the internal energies. Tentative interpretations of the transitions involved are given. (France)

7530 NONPARTIAL-WAVE TREATMENT OF REACTIVE AND NONREACTIVE SCATTERING: COUPLED INTEGRAL EQUATION FORMALISM. Hayes, E. F. (Rice Univ., Houston, Tex.); Kouri, D. J. Chem. Phys. Lett.; 11: No. 3, 233-7(15 Oct 1971).

Coupled integral equations are derived for the full scattering amplitudes for both reactive and nonreactive channels. The equations do not involve any partial-wave expansion and are obtained using channel operators for reactive and nonreactive collisions. These coupled integral equations are similar in nature to equations derived for purely nonreactive collisions of structureless particles. Using numerical quadrature techniques, these equations may be reduced to simultaneous algebraic equations, which may then be solved. (auth)

7531 POTENTIAL CURVES FOR Na_2^+ AND RESONANCE CHARGE-TRANSFER CROSS SECTIONS. Bottcher, C.; Allison, A. C.; Dalgarno, A. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). Chem. Phys. Lett.; 11: No. 3, 307-9(15 Oct 1971).

A model potential method, applied earlier to Li_2^+, is used to calculate the six lowest potential-energy curves of Na_2^+. Charge-transfer cross sections are calculated for Li^+ on Li and Na^+ on Na and found to be in reasonable agreement with experiment. (auth)

7532 QUANTUM-MECHANICAL IMPLUSE APPROXIMATION: APPLICATION TO VIBRATIONAL INELASTIC SCATTERING. Eckelt, P.; Korsch, H.-J. (Univ., Muenster, Ger.). Chem. Phys. Lett.; 11: No. 3, 313-17(15 Oct 1971).

The quantum mechanical impulse approximation is applied to vibrational excitation of a diatomic molecule by collinear collision with a third atom. These calculations are compared with other theoretical results (exact quantum mechanical, semiclassical, classical) and with experimental data from O_2^+–He collisions. (auth)

7533 GROUP THEORETICAL SELECTION RULES FOR ELECTRON-IMPACT SPECTROSCOPY. Goddard III, W. A. (California Inst. of Tech., Pasadena); Huestis, D. L.; Cartwright, D. C.; Trajmar, S. Chem. Phys. Lett.; 11: No. 3, 329-33(15 Oct 1971).

Simple group theoretical principles are applied to the consideration of electron scattering by atoms and diatomic and polyatomic molecules. For all scattering angles $S_g \longrightarrow S_u$ is forbidden for atoms. For axial scattering (0 or 180° scattering angle), $\Sigma^+ \not\leftrightarrow \Sigma^-$ for linear polyatomic molecules and $S_g \not\leftrightarrow P_g \not\leftrightarrow D_g$, etc., for atoms. This approach is also used to estimate relative strengths of electron-impact-induced transitions of diatomic and polyatomic molecules. (auth)

7534 CLASSICAL STUDY OF THE INFLUENCE OF INDUCED ROTATION AND ANISOTROPY EFFECTS ON ENERGY TRANSFER BETWEEN AN ATOM AND A DIATOMIC MOLECULE. Bergeron, G.; Chapuisat, X. (Paris Univ., Orsay, France). Chem. Phys. Lett.; 11: No. 3, 334-8(15 Oct 1971).

The lagrangian equations of motion for a mass-4 atom colliding with a mass-2 diatomic molecule are solved numerically in order to investigate the validity of some approximations often used in energy-transfer theory. The results are shown to be very sensitive to the details of the intermolecular potential; the effect of induced rotation can change the vibrational energy transfer by an order of magnitude. (auth)

7535 EXCITATION CROSS SECTIONS FOR COLLISIONS OF ALKALI ATOMS WITH MOLECULES: THRESHOLDS AND ENERGY DEPENDENCE FROM 1 TO 10 eV. Kempter, V.; Mecklenbrauck, W.; Menzinger, M.; Schlier, Ch. (Univ., Freiburg i. B.). Chem. Phys. Lett.; 11: No. 3, 353-5(15 Oct 1971).

Sputtered Na and K beams were used to study collisional excitation of alkali atoms by molecules. $Na^*(3^2P)$ and $K^*(4^2P)$ were detected by their radiative decay. There are some indications that excitation of other states may play an important role at higher energies. (auth)

7536 SCATTERING OF HELIUM BY HELIUM AT INCIDENT BEAM ENERGIES FROM 300 TO 3000eV. Savola, William John Jr. Storrs, Conn.; Univ. of Connecticut (1971). 102p. University Microfilms Order No. 71-29,907.

Thesis.

The mutual collision cross section for the scattering of He by He is measured in an energy range from 300 to 3000 eV in increments of 100 eV. Measurements are made with detector geometric angular resolutions of 0.056° and 0.260° on an apparatus that employs hole–hole geometries for both the incident beam and detector collimations. The incident neutral beam is formed by resonant charge exchange of a mass-analyzed He^+ beam produced in an electron-impact ion source. Data are taken at each energy using a "continuous attenuation" technique, which yields plots of signal reaching the detector versus target gas density. Parametric values for an inverse-power point potential are determined from the cross-section data and provide numerical values for the He–He elastic scattering potential between 0.92 Å and 1.99 Å. The cross section data taken with an angular resolution of 0.056° make it possible to extend the range of an experimentally determined potential to larger interatomic separations than has previously been reported. Small-angle differential measurements are made in $1/20$° increments out to 1.25° at incident-beam energies of 1800 3000 eV. The scattered signal is found to decrease monotonically with increasing scattering angle. As an estimate of the importance of inelastic contributions to the mutual collision cross section, the ratio of ions (produced from neutral–neutral collisions) to total signal at each angle is measured. The 3000-eV data begin to show evidence of ions at about 0.80°; the ratio of ions to total signal increases thereafter with increasing angle until it is about 10% at 1.25°. No evidence of ionization is found in the 1800-eV data. The effect of quantum scattering is also discussed. (Diss. Abstr. Int., B)

7537 SEMICLASSICAL TREATMENT OF INELASTIC ATOMIC COLLISIONS. Bates, D. R. (Queen's Univ., Belfast). Comments At. Mol. Phys.; 3: No. 1, 23-30(Oct-Nov 1971).

A review is presented with emphasis on the one-dimensional and three-dimensional JWKB approximations. Other aspects are covered by the references. (23 references) (UK)

7538 ATOM–ATOM AND ATOM–ION COLLISIONS. I. COLLISIONS BETWEEN NEUTRAL ATOMS IN WHICH NO EXCITATION OCCURS. Massey, Harrie (University Coll., London). Contemp. Phys.; 12: No. 6, 537-58(Nov 1971).

The wavelengths associated with the motion of atoms and molecules at ordinary temperatures are short compared with the effective range of interaction between them. Nevertheless, interference effects may be observed. Their detailed study, which is now possible because of developments in experimental technique, provides much information about the details of the interatomic forces. Although the effects arise because of the wave aspect, they may be discussed to a very great extent in terms of a semiclassical approximation, in which the phases as well as the amplitudes of the waves concerned can be derived with very good accuracy from classical mechanics. Interference effects associated with collisions in which no change of internal energy of the colliding system occurs are considered, and collisions between neutral atoms discussed. An account is given of the semiclassical theory and of the rainbow and glory interference effects, analogous to the corresponding meteorological phenomena. This is followed by a description of the experimental methods used to observe the effects and of some of the results obtained. (auth)

7539 POSSIBILITY OF PRODUCING SPIN-POLARIZED HYDROGEN ATOMS BY CHARGE-TRANSFER COLLISIONS WITH Xe. Macek, J.; Shakeshaft, R. (Univ. of Nebraska, Lincoln). Phys. Rev. Lett.; 27: No. 22, 1487-9(29 Nov 1971).

It is argued that hydrogen atoms formed by charge-transfer reactions with Xe at an incoming proton energy of 15 eV could be spin-polarized. A detailed numerical calculation of the charge-transfer probability and the spin-polarization fraction indicates that a spin polarization as large as 70% may occur while the charge-transfer probability is simultaneously 0.6. (auth)

7540 MEASUREMENT OF THE EFFECTIVE CROSS SECTIONS FOR EXCITATION OF BANDS IN THE VISIBLE RANGE OF THE SPECTRUM OF CO MOLECULES AND CO^+ IONS BY 0.4 TO 20 keV ELECTRONS. Koppe, V. T.; Koval, A. G.; Danilevskii, N. P.; Popova, L. I.; Fizgeer, B. M. (Kharkov State Univ.). Zh. Eksp. Teor. Fiz.; 61: No. 3, 906-11(Sep 1971). (In Russian).

The effective cross sections for excitation (σ) by electron impact (E = 4 keV) of 14 bands in the CO^+ ion comet-tail band system (CO^+ cts), two bands of the CO^+ Balde–Johnson system, and two bands of the CO molecule Angstrem system are measured. The excitation functions of the (2-0), (2-3), (3-0), (0-1), (1-0), and (1-1) bands of the comet-tail system, the (0-1) band of the Balde–Johnson system, and (1-0) band of the Angstrem system are measured at electron energies between 0.4 and 20 keV. For all bands studied the experimental $\sigma(E)$ dependences at energies $E > 0.4$ keV satisfactorily agree with the respective dependences calculated in the Born approximation. The dependence of the electron transition moment Re on internuclear distance r is calculated for the CO^+ cts on the basis of the experimental data. (auth)

7541 PERTURBATION THEORY OF MULTIPHOTON IONIZATION OF ATOMS. Zon, B. A.; Manakov, N. L.; Rapoport, L. P. (Voronezh State Univ., USSR). Zh. Eksp. Teor. Fiz.; 61: No. 3, 968-75(Sep 1971). (In Russian).

A method is proposed for summation of perturbation theory series that describe multiphoton ionization of atoms. Underlying the method is application of the Green function for an optical electron in a complex atom; the function is set up in the approximation of the quantum defect theory. Numerical calculations are carried out for three-photon ionization by linear and circularly polarized light of the ground and metastable hydrogen levels and metastable singlet and triplet helium levels. (auth)

7542 CROSS SECTIONS FOR THE COLLISION OF THALLIUM ($6^2P_{1/2}$ AND $6^2P_{3/2}$) WITH I_2. Gedeon, A.; Edelstein, S. A.; Davidovits, P. (Yale Univ., New Haven). J. Chem. Phys.; 55: No. 11, 5171-4 (1 Dec 1971).

The inelastic collision cross sections with I_2 were measured for the ground state ($6^2P_{1/2}$) and the metastable state ($6^2P_{3/2}$) of thallium. The thallium atoms were produced in the presence of a known amount of I_2 by photodissociating TlI salt vapor with a short pulse of uv light. The cross sections were computed from the decay rate of the thallium density. It was observed that the collision of the metastable state with I_2 results in the de-excitation of the state rather than in chemical reaction. The cross section for the process $Tl(6^2P_{1/2}) + I_2 \rightarrow TlI + I$ is 105 Å^2 and for the process $Tl(6^2P_{3/2}) + I_2 \rightarrow Tl(6^2P_{1/2}) + I_2$ is 159 Å^2. These results are in good agreement with theory. (auth)

7543 CALCULATION OF CROSS SECTIONS FOR SPIN RELAXATION OF ALKALI ATOMS IN THE GROUND STATE IN COLLISION WITH INERT-GAS ATOMS. Dashevskaya, E. I.; Kobzeba, E. A. Opt. Spectrosc. (USSR) (Engl. Transl.); 30: No. 5, 436-8(May 1971).

The cross section is calculated for spin flip in the ground state of rubidium and sodium atoms in collision with helium atoms under the assumption of a spin–orbit relaxation mechanism. The dependence of cross section on temperature is obtained. The theoretical results are compared with experimental data. (auth)

7544 INELASTIC COLLISIONS OF HIGHLY EXCITED ATOMS. Smirnov, V. A.; Mikhailov, A. A. Opt. Spectrosc. (USSR) (Engl. Transl.); 30: No. 5, 525-6(May 1971).

The impact-parameter method is used to study the mechanisms leading to energy-level transitions during collisions of highly excited atoms. The effect of dipole-moment vibrations and the possibility of charge exchange are considered. (A.G.W.)

7545 GLAUBER APPROXIMATION IN INELASTIC e–H SCATTERING. Ghosh, A. S.; Sil, N. C. (Indian Association for the Cultivation of Science, Jadavpur). Indian J. Phys.; 44: No. 3, 153-61(Mar 1970).

The Glauber approximation was used to calculate the total and the differential cross sections for 1s–2s and 1s–2p excitations in e–H scattering. In the intermediate energy region, the results for the total cross section of 1s–2p excitation are in better agreement with the experimental observations than other existing theoretical results. In the case of 1s–2p excitation the total-cross-section curve almost coincides with the experimental findings. The differential cross sections for both the cases are more sharply peaked in the forward direction than those calculated by the Born approximation. (auth)

7546 PRODUCTION OF H_1^+ AND H_2^+ IONS BY THE DISSOCIATION OF H_3^+ AND H_2^+ IONS IN THE BOMBARDMENT OF A WATER TARGET. Dagnac, R.; Angles, J. M.; Blanc, D.; Molina, D.; Pradal, R. (Univ., Toulouse). Compt. Rend., Ser. B; 273: No. 12, 460-3(20 Sep 1971). (In French).

A water-vapor target was bombarded with a beam of H_2^+ and H_3^+ ions with energies between 2 and 50 keV. The dissociation products were studied, and the total formation cross sections involved in the production of the charged H_1^+ and H_2^+ particles and the neutral H^0, H_2^0 particles were measured. (France)

7547 ABSOLUTE EXCITATION CROSS SECTIONS FOR THE 4 ^{1}S, 4 ^{1}D, AND 3 ^{1}P LEVELS OF HELIUM EXCITED BY FAST PROTONS. Hasselkamp, D.; Hippler, R.; Scharmann, A.; Schartner, K. H. (Univ., Giessen, Ger.). Z. Phys.; 248: No. 3, 254-63(1971).

Absolute cross sections for proton excitation of the 3 ^{1}P, 4 ^{1}S and 4 ^{1}D levels of He were measured in the energy range from 200 keV to 1 MeV. Calibration with a tungsten lamp mounted in the collision chamber and normalization on the high-energy first Born approximation 3 ^{1}P values for protons and electrons were used to obtain absolute data. At 1 MeV the experimental results agree within 10% with the first Born approximation values. (auth)

7548 PERTURBATION TREATMENT OF THE VARIABLE-PHASE METHOD. Landman, Uzi (Univ. of California, Santa Barbara. Univ. of Illinois, Urbana). Phys. Rev., A; 5: No. 1, 1-4(Jan 1972).

A perturbation treatment of the variable-phase method for scattering is presented. The zeroth-order phase shift is given by the solution of a first-order nonlinear differential equation. The perturbation corrections are given as the solutions of first-order nonhomogeneous but linear differential equation. A variational procedure for the optimization of the zeroth-order approximation is formulated. The results of a test calculation for the s-wave scattering from an attractive exponential potential are included. (auth)

7549 DIRECT DEMONSTRATION OF SPIN-ANGULAR-MOMENTUM CONSERVATION IN THE REACTION $He(2^3S_1) + He(2^3S_1X) \rightarrow He(1^1S_0) + He^+ + e^-$. Hill, J. C.; Hatfield, L. L.; Stockwell, N. D.; Walters, G. K. (Rice Univ., Houston, Tex.). Phys. Rev., A; 5: No. 1, 189-95(Jan 1972).

Conservation of spin angular momentum in the reaction $He(2^3S_1) + He(2^3S_1) \rightarrow He(1^1S_0) \rightarrow He^+ + e^-$ is demonstrated quantitatively in the afterglow of a helium discharge by measuring the dependence of the electron production rate upon 2^3S_1 spin-state populations, which are manipulated by an optical-pumping technique. (auth)

7550 COMBINED VARIABLE-PHASE–R-MATRIX APPROACH TO SCATTERING PROBLEMS. Matese, John J.; Henry, Ronald J. W. (Louisiana State Univ., Baton Rouge). Phys. Rev., A; 5: No. 1, 222-6(Jan 1972).

A procedure that combines the methods of variable-phase and R-matrix theory is formulated for multichannel scattering processes. R-matrix theory is used to obtain the logarithmic derivative of the scattering functions at a radius a, beyond which all exchange potentials are negligible. Variable-phase theory is used to construct a radially dependent reaction matrix, which is integrated from a to infinity. The method is applied to a two-channel model that has some of the features of the low-energy electron–hydrogen problem. Essentially exact results are obtained with as few as 40 R-matrix states (20 per channel). (auth)

7551 DISTRIBUTIONS IN ENERGY AND ANGLE OF ELECTRONS EJECTED FROM MOLECULAR HYDROGEN BY 0.3- TO 1.5-MeV PROTONS. Toburen, L. H.; Wilson, W. E. (Battelle Memorial Inst., Richland, Wash.). Phys. Rev., A; 5: No. 1, 247-56(Jan 1972).

Cross sections for the ejection of electrons, differential in electron energy and angle of emission, were measured for energetic protons on molecular hydrogen. Electron-energy distributions are presented for ten angles between 20° and 130° for each of five proton energies between 0.3 and 1.5 MeV. The results are compared with calculations based on binary-encounter theory, the Born approximation, and the Faddeev equations. Qualitative agreement with the latter provides supporting evidence for the inclusion of a long-range electron–proton interaction in the collision theory for proton energies as high as 1.5 MeV. (auth)

7552 FORMATION OF H(2p) AND H(2s) IN COLLISIONS OF 1- TO 25-keV HYDROGEN ATOMS WITH RARE GASES. Birely, J. H.; McNeal, R. J. (Aerospace Corp., El Segundo, Calif.). Phys. Rev., A; 5: No. 1, 257-65(Jan 1972).

Cross sections were measured for the emission of Lyman-α radiation in collisions of 1- to 25-keV hydrogen atoms with He, Ne, Ar, Kr, and Xe owing to excitation of the fast atom to the 2p and 2s states. The intensity of Lyman-α emitted spontaneously from collisionally excited H(2p) was measured at 54.7 or 125.3° with respect to the H beam in an essentially field-free collision chamber with an oxygen-filtered photometer calibrated by reference to previous results for H^+ on Ar. After a small correction for cascade effects, the data yield the cross sections for population of the 2p state in these collisions. An electric field, oriented in the direction of the beam, was applied within the collision chamber to quench collisionally excited H(2s), and the resulting increase in Lyman-α radiation was used to derive the cross sections for formation of the 2s state. The viewing geometry and the electric field orientation were designed to minimize the effects of polarization of the light emitted from H(2p) and H(2s) and of changes of polarization when the quenching electric field was applied; these effects might otherwise lead to large errors in the 2s cross section. The cross sections increase in magnitude and degree of structure with increasing atomic number of the target. Except for collisions with Ne, excitation of H(2p) is always more probable than excitation of H(2s). A relationship between the emission and stripping cross sections is presented, the relative probabilities of excitation and stripping being rather independent of target. These results are compared with previous measurements made at higher energies and with theoretical estimates of these cross sections. The present extension of previous results to lower energy has revealed new structure in the energy dependence of the cross sections for the heavier targets. Existing theoretical treatments of these collisions fail to yield either the magnitude or energy dependence of the cross sections at energies below 5 keV. (auth)

7553 VIBRATIONALLY INELASTIC LOW-ENERGY CO^+–Ar COLLISIONS. Petty, Frederick; Moran, T. F. (Georgia Inst. of Tech., Atlanta). Phys. Rev., A; 5: No. 1, 266-76(Jan 1972).

Relative differential cross sections for inelastic scattering of CO^+ by Ar were examined with a high-resolution ion-beam apparatus in which a CO^+ beam interacts with a neutral-Ar beam and the energy, mass, and angular distribution of scattered ions are measured. Maxima in the inelastic energy-loss spectra occur at energies corresponding to CO^+ spectroscopic vibrational spacings. The probabilities of multiquantum vibrational transitions are found to increase with both reactant-ion kinetic energy and scattering angle. Cross sections for vibrational excitation at small scattering angles are adequately described by a semiclassical oriented-nonlinear-encounter model in which an impact-parameter treatment is used to estimate collisional energy transfer for a forced oscillator, and time-dependent wave functions are employed to evaluate vibrational transition probabilities. The energy width of the inelastic peaks indicated that simultaneous vibrational–rotational excitations occur. Weakly inelastic processes are observed below the threshold for vibrational energy loss, corresponding to rotational excitation with the relative importance of rotational transitions increasing with decreasing energy and scattering angle. (auth)

7554 ROTATIONAL–VIBRATIONAL EXCITATION OF H_2 BY SLOW ELECTRONS. Henry, Ronald J. W. (Louisiana State Univ., Baton Rouge); Chang, Edward S. Phys. Rev., A; 5: No. 1, 276-84(Jan 1972).

The frame-transformation theory is applied to a calculation of electron scattering from H_2 in the energy range of 1 to 10 eV. Results are presented for differential as well as integrated cross sections for pure vibrational and rotational–vibrational excitation processes. These calculations are in very satisfactory agreement with experiment and are subject to easy interpretation. (auth)

7555 DISTRIBUTION OF EXCITATION TRANSFER IN HELIUM. Jobe, John D.; St. John, Robert M. (Univ. of Oklahoma, Norman). Phys. Rev., A; 5: No. 1, 295-308(Jan 1972).

The distribution of atom–atom collisional excitation among various levels of the helium atom is determined. The determination is made by analyzing absolute measurements of the optical electron excitation cross sections of 63 levels at 100 eV electron energy and 63 mtorr pressure. Factors pertaining to our method of obtaining absolute optical cross sections are discussed in some detail. Collisional-excitation transfer on the n = 3 level is found to be slight with a cross section for 3^1P to 3^1D transfer of less than 1.2×10^{-15} cm^2. A detailed analysis is made on the n = 4 level, and collisional-excitation-transfer cross sections are found to be $(4.7 \pm 1.5) \times 10^{-14}$ cm^2 for 4F to 4D transfer and $(2.3 \pm 0.6) \times 10^{-14}$ cm^2 for 4^1P to 4F transfer. The pressure dependence of the apparent electron excitation cross sections of 47 levels is also presented at 100 eV electron energy. This work shows that the apparent cross sections of levels with large principal quantum numbers decrease as the pressure increases, an effect opposite to that observed for levels of low principal quantum number. A short discussion explains these phenomena in terms of a cyclic energy-exchange process, which includes electron excitation, imprisonment of resonance radiation, collisional excitation transfer, and radiative transfer. In the course of this investigation it was necessary to obtain values for the electron excitation cross sections of the n^1P series up to n = 10. The values showed good agreement with Born-approximation theoretical cross sections. (auth)

7556 EFFECTS OF APPROXIMATE CLUSTER FUNCTIONS ON SCATTERING PARAMETERS AND AN IMPROVED PSEUDOSTATE EXPANSION FOR MANY-PARTICLE SCATTERING. Hahn, Yukap (Univ. of Connecticut, Storrs). Phys. Rev., A; 5: No. 1, 309-17(Jan 1972).

The effects on scattering parameters of approximate cluster functions that appear in the asymptotic boundary conditions are examined by a model calculation of the elastic electron–hydrogen scattering. It is shown that (i) the resonance energies calculated with functions orthogonal to the approximate open-channel functions could be spurious, (ii) the phase shifts could deviate from the correct values as much as the relative error in the cluster functions, and (iii) the threshold mismatch may cause an enhancement of phase shifts. An improved pseudostate expansion is studied in which the prediagonalization of the cluster energy matrix is emphasized. This is seen not only to improve the threshold energies and incorporate the effect of the continuum states, but also to optimize the input functions in a given calculation. An additional diagonalization of the closed-channel energy matrix provides a set of quasi states for the resonance and distortion potentials. (auth)

Atomic Theory

Refer also to abstracts 8000 and 8342.

7557 (NYO–3829-75) BEHAVIOR OF ELECTRON WAVE FUNCTIONS NEAR THE ATOMIC NUCLEUS AND NORMALIZATION SCREENING THEORY IN ATOMIC PHOTOEFFECT. Pratt, R. H.; Tseng, H. K. (Pittsburgh Univ., Pa. Dept. of Physics). Aug 1971. Contract AT(30-1)-3829. 39p. Dep. NTIS.

The behavior of electron wave functions near the atomic nucleus is discussed. It is shown that point-Coulomb shapes persist to quite large distances for bound states and also for energy-shifted continuum states. The screening effects on continuum-state normalizations cancel the screening effects on the kinematic factor pE in matrix elements. These results are used to examine the normalization screening theory in atomic photoeffect. It is argued that this theory, which describes screening effects simply as a change in normalization, can be good to 1% for photon energies more than 10 keV above the K shell threshold in Al, 30 keV in Cu, 60 keV in Sn, 150 keV in Pb, and 200 keV in U. This agrees well in order of magnitude with exact numerical calculations. (auth)

7558 (SC-RR-69-569) WAVE FUNCTION PROPERTIES FOR ACCURATE ATOMIC SCATTERING FACTOR CALCULATIONS. Mendelsohn, Lawrence B. (Sandia Labs., Albuquerque, N. Mex.). Aug 1969. 18p. Dep. NTIS.

Expansions for the atomic coherent scattering factor are obtained for both small and large values of the momentum transfer (q). The condition on an approximate wave function that it give an accurate value of magnetic susceptibility is shown explicitly via a model problem calculation to be of more importance than the "energy criterion" if one desires accurate values of the scattering factor for small momentum transfers. For large momentum transfers, the leading term in the scattering factor expansion is found to be proportional to q^{-4}, with a coefficient that depends on the radial derivative of the electron density at the nucleus. A discussion of the accuracy of Hartree–Fock scattering factors for both small and large momentum transfers is given. (auth)

7559 LORENTZ GROUP SYMMETRY OF THE HYDROGEN ATOM AND THE COULOMB T MATRIX. Rajagopal, A. K.; Shastry, C. S. (Louisiana State Univ., Baton Rouge). J. Math. Phys. (N. Y.); 12: No. 11, 2387-94(Nov 1971).

The existence of solutions for the Lippmann–Schwinger (LS) equation for the Coulomb problem is studied by investigating whether its kernel belongs to the Hilbert–Schmidt (HS) class. The kernel for each partial wave is shown to belong to the HS class for complex energies whereas for real energies it becomes unbounded. Unlike the case of short-range potentials, e.g., the Yukawa potential, even the suitably symmetrized kernel does not belong to the HS class for real, positive energies. These formal properties strongly indicate that a unique limit for the partial-wave off-shell Coulomb T matrix as it approaches the unitarity axis may not exist. It is found that, exploiting the O(4) symmetry of the Coulomb Hamiltonian (H) in the subspace of the negative spectrum of H and the O(3,1) symmetry in the subspace of the positive spectrum of H, one can construct the off-shell Coulomb T matrix in terms of the eigensolutions (Sturmians) of the kernel of the Lippmann–Schwinger equation. These follow from the work of Perelemov and Popov, and Schwinger on the Coulomb Green's function. On the basis of the generating functions for the Sturmians, various integral, contour integral, and discrete sum representations for the complete off-shell Coulomb T matrix are derived. In this way, it is demonstrated that the T matrix has a nonunique limit as one approaches the unitarity axis. It is also shown that when the asymptotic Coulomb distortion is taken into account, the physical Coulomb amplitude can be deduced from this Coulomb T matrix. These results, incidentally, rectify some errors in the earlier works. Since for both negative and positive energies the Coulomb T matrix is obtained as the explicit solution of the LS equation, the validity of the generalized unitarity—the Low equation—in a certain sense is guaranteed. This is proved, in a general way, by showing that a generalized Low equation follows when the energy is complex only from the LS equations and some defining relations; in the Coulomb case the generalized unitarity relationship for real energies must be interpreted as the limit when the imaginary part becomes zero. (auth)

7560 INTEGRAL-TRANSFORM-GENERATED BASIS SETS. Yue, C. P.; Somorjai, R. L. (National Research Council of Canada, Ottawa). J. Chem. Phys.; 55: No. 9, 4594-4600(1 Nov 1971).

Two alternative versions of a procedure for generating new basis sets via the integral-transform (IT) method are outlined. The first version (fixed shape function, set of primitive functions) is tested on 3-electron (Z = 2, 3, 4, 5) and 4-electron (Z = 3, 4, 5, 6) atomic systems (ground state) and the 2^1P excited state of He. The set of primitive functions are either hydrogenic or Slater orbitals and the shape function is the square pulse that generates the Hulthèn transforms. In these calculations, a conjecture about the dependence of the parameters of higher principal quantum number (n) IT orbitals on the parameters of lower n IT orbitals is also tested and substantiated. The second version (single primitive function, set of shape functions) is tested on the 2^1P state of He. The primitive function is a 1s Gaussian function, the set of shape functions is related to the set of generalized Laguerre polynomials $L_n^{v-1}(x)$. The first member of this set gives $k_v(qr)$, the reduced modified Bessel function of the second kind, already used in ground-state atomic and molecular calculations. The results are analyzed critically. (auth)

7561 SIMPLE DIATOMICS-IN-MOLECULES ENERGY EXPRESSION FOR M_3^+ AND ITS APPLICATION TO H_3^+. Huang, Jantsyu J. (Univ. of Notre Dame, Ind.). J. Chem. Phys.; 55: No. 10, 5136-7(15 Nov 1971).

The diatomics-in molecules theory is used to obtain a simple energy expression for M_3^+ ions. The expression is applied to the case of H_3^+, and results are compared with results of other calculations. A possible lower bound on the true energy is discussed briefly. (A.G.W.)

7562 EFFECTS OF ATOMIC INTERACTIONS ON THE ABSORPTION AND EMISSION OF RADIATION: THE CASE OF THREE ATOMS. Freedhoff, Helen S. (York Univ., Toronto). J. Chem. Phys.; 55: No. 10, 5140-2(15 Nov 1971).

A formalism used previously (Can. J. Phys., 45: 1833(1967)) for a general system of N atoms is applied to the three-atom case to calculate the eigenstates of the system and its absorption and emission spectra. It is pointed out that the assumption that the radiative lifetime of a three-atom system is the inverse of the transition probability at t = 0 used in a calculation by Lurie (J. Chem. Phys., 50: 3235(1969)) is valid only if the decay of the initial state of the system is exponential in time. (A.G.W.)

7563 ONE-CENTER r_{ij} INTEGRALS OVER SLATER-TYPE ORBITALS. Sims, James S. (Ames Research Center, Moffett Field, Calif.); Hagstrom, Stanley A. J. Chem. Phys.; 55: No. 10, 4699-4710(15 Nov 1971).

Expressions are derived for the integrals that arise in calculations of atomic wave functions of four or more electrons, utilizing the method of explicit introduction of interelectronic distances r_{ij} into a configuration-interaction wave function (subject to the restriction of at most one r_{ij} per configuration). The approach followed in the derivations is similar to one followed by Öhrn and Nordling for three-electron integrals; however, in extending the Öhrn and Nordling scheme to four electrons for a basis of s, p, and d Slater-type orbitals, numerical snags are encountered, which have been obviated by an Euler transformation on certain of the auxiliary integrals. (auth)

7564 VARIATIONAL METHODS IN THE WAVE OPERATOR FORMALISM. A UNIFIED TREATMENT FOR BOUND AND QUASI-BOUND ELECTRONIC AND MOLECULAR STATES. Micha, David A.; Braendas, Erkki (Univ. of Florida, Gainesville). J. Chem. Phys.; 55: No. 10, 4792-7(15 Nov 1971).

The wave operator formalism of Löwdin, heretofore used to describe states belonging to the discrete energy spectrum, has been extended to unify the treatment of bound and quasi-bound (or decaying) states. The approach makes use of an arbitrary reference function that may be chosen to approximate the physical state at short distances. Real and complex eigenvalues are obtained, respectively, for bound and quasi-bound states from an implicit equation, valid for all coupling strengths. Resonance positions and line-widths are explicitly independent of energy. Variational principles of the Lippmann–Schwinger type are presented, which apply to states with either bound-state or decay boundary conditions. Particular cases leading to minimization or maximization principles for real energies are discussed. The formalism is considered in connection with decaying electronic states of atoms and decaying molecular states. (auth)

7565 UPPER AND LOWER BOUNDS FOR EXPECTATION VALUES. Wang, P. S. C. (Simon Fraser Univ., Burnaby, Can.). Chem. Phys. Lett.; 11: No. 3, 318-22(15 Oct 1971).

New upper and lower bounds for quantum-mechanical expectation values are derived from the positivity condition for Gram determinants. These bounds are strengthened forms of those proposed recently by Mazziotti and Parr. As an illustrative example error bounds are calculated for the inverses of the electron–nucleus and interelectronic distances in the ground and first excited ^1S states of the helium atom and compared with those of Jennings and Wilson, Weinhold, and Mazziotti and Parr. (auth)

7566 RELATIVISTIC AND CORRELATION EFFECTS FOR BOUND LEVELS OF ATOMIC SYSTEMS WITH THREE ELECTRONS. Beck, Donald R.; Odabasi, Halis (Univ. of Colorado, Boulder). Ann. Phys. (N. Y.); 67: No. 1, 274-345(Sep 1971).

A theoretical apparatus was developed that allows accurate calculation of atomic energy levels whose dominant configurations are of the three-electron, one p-hole and two-electron, or one-electron type. Correlation effects are incorporated through a configuration-interaction expansion of Slater determinants in which the radials are found by solving the Hartree–Fock–Slater equation. The relativistic effects are incorporated by using the low-Z Pauli approximation for the Hamiltonian. The discussion is made general enough so that results for configurations with more than three electrons can be generated (with a substantial amount of algebraic manipulation) and approximations to the Hamiltonian, other than that of Pauli, can be considered (with a small amount of algebraic manipulation). The one p-hole two-electron theory is then applied to Na I, Mg II, and Cs I to obtain the fine structure of the energetically lowest D doublets. For Na I, Mg II, and Cs I, the calculated values are (in cm^{-1}) –0.038, –0.42, and +102.41, respectively. The observed values are (in cm^{-1}) –0.050, –0.87, and +97.59, respectively. The three-electron theory is applied to the N = 13 isoelectronic series (up to Ca) to explain the doublet D fine structure associated with the $3s3p^2$ configuration. A substantial improvement over the single-configuration, non-relativistic results is obtained. (73 references) (auth)

Cosmic Radiation

Refer also to abstracts 6892, 6907, 6911, 6912, 7272, 7377, 7381, 7470, 7477, 7650, 7767, 7769, 7784, 7785, 7798, 7800, 7804–7807, 7824, 7842–7844, 7885, 7886, 7914, 7921–7925, and 7997–7999.

7567 (AECL–4059) COSMIC RAY NEUTRON AND MUON MONITOR DIURNAL VECTORS. VI. From the Start of Solar Rotation No. 1867 to the End of Solar Rotation No. 1879 (January 17, 1970–January 2, 1971) and Vector Diagrams by Solar Rotation. Steljes, John F. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Oct 1971. 121p. Dep. NTIS (U. S. Sales Only). AECL $2.50.

Daily diurnal and semidiurnal variation vectors for both the muon and the neutron monitors at four cosmic-ray stations in Canada that have equipment maintained by AECL are given in tabular form for the period from the start of solar rotation No. 1867 to the end of rotation No. 1879. The same vectors for the AECL neutron and muon monitors at Kula, Hawaii, and for the Bolivian neutron monitor at Chacaltaya are also given. The vectors were corrected for barometer and in the case of the muons, except at Kula, for the atmospheric temperature wave using hourly values of the temperature and barometric pressure measured near the ground. Graphs of the vectors at each station for successive solar rotations are also given. (auth)

7568 (AECL–4060) COSMIC RAY NM-64 NEUTRON MONITOR DATA. XIX. Monthly Graphs, May–August 1971. Steljes, J. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Oct 1971. 71p. Dep. NTIS (U. S. Sales Only). AECL $2.00.

Uncorrected and barometer-corrected results from the cosmic-ray stations in Canada using equipment maintained by AECL are given in tabular form for the period from May to August 1971. Normalized graphs are given for the same period. Correction factors for the constant rates of drift of the barometers at each of the four stations are given. A small flare increase occurred on September 1–2, 1971. (auth)

7569 USE OF CORRELATION FUNCTIONS AS PARAMETERS FOR ACTIVITY OF COSMIC RADIATION. Chaloupka, P. (Inst. of Experimental Physics, Kosice, Czech.); Dubinsky, J.; Fischer, S.; Kowalski, T. Fyz. Cas.; 20: No. 4, 231-42(1970).

The use of correlation functions of the cosmic-ray intensities recorded at various observatories is suggested as a parameter of the cosmic-ray activity. The maximum value of the correlation coefficient depends on the amplitude of the cosmic-ray variations, both isotropic and anisotropic, and for a given pair of observatories, it characterizes the degree of intensity variations. Examples are listed for the period 1963 to 1964 and for May 1966. (NSA of Czech)

7570 TWO-, THREE-, AND FOUR-PARTICLE SPATIAL CORRELATIONS AMONG TERTIARY COSMIC RAY MUONS. Busath, D. D.; Stenerson, R. O. (Univ. of Utah, Salt Lake City). Nucl. Phys.; B35: No. 1, 141-59(1971).

Showers of muons which result from interactions of primary cosmic rays high in the atmosphere appear deep underground as bundles of nearly parallel muons. For threshold energies of 1 TeV and arrival zenith angles of 45 degrees, those events having a small mean number of muons are described by a power law distribution in shower size having an exponent of $\simeq -3.7$ and a radial density distribution that decreases with distance R from the shower axis a little less rapidly than $\exp(-R/5.4\text{ m})$. Comparison of new data on four muon spatial correlations in terms of the same phenomenology with data on two and three muon spatial correlations from previous experiments suggests that the shower size distribution steepens and the shower radial density distribution broadens with increasing shower size (i.e., with increasing mean-energy of the primary cosmic ray at a given threshold energy of the muons observed). These results might be explained by a basically geometrical effect due either to a total inelastic cross section which rises with energy or by an enhanced contribution from the interactions of secondaries. If the effect does not have a geometrical origin, then it may be necessary to reformulate the input to shower development calculations which have assumed that interaction products are described by factored, uncorrelated single particle statistical distributions. The relationships between the inclusive distribution predicted by theory and those of the empirical phenomenology are explored in some detail. (auth)

7571 EVIDENCE FOR A PRIMARY COSMIC-RAY PARTICLE WITH ENERGY 4 x 10^{21} eV. Suga, K.; Sakuyama, H.; Kawaguchi, S.; Hara, T. (Tokyo Univ.). Phys. Rev. Lett.; 27: No. 23, 1604-7(6 Dec 1971).

The analysis of an extremely energetic air shower produced by a primary cosmic-ray particle of energy 4×10^{21} eV is described. The arrival direction of this cosmic ray was right ascension 20 h 14.5 min and declination 24°. The directions of 3C 409 (radio source) and AP 2015 + 28 (pulsar) are inside the uncertainty of the arrival direction. Information on muons and the total number of charged particles in this air shower indicated no drastic change of nuclear interactions from 10^{17} to 10^{21} eV. (auth)

7572 ANTIPROTONS IN THE PRIMARY COSMIC RADIATION NEAR THE GEOMAGNETIC EQUATOR. Durgaprasad, N.; Kunte, P. K. (Tata Inst. of Fundamental Research, Bombay). Nature (London) Phys. Sci.; 234: No. 47, 74-5(22 Nov 1971).

The small abundance of antiprotons in primary cosmic rays is so far unknown, although upper limits on their abundance relative to protons have been reported. The present authors attempted to estimate this abundance from the measured asymmetrical fluxes of singly charged particles at large zenith angles in the E, W, N, and S directions, and the flux in the vertical direction. The asymmetries are larger near the geomagnetic equator, and the estimates of antiproton flux are based mainly on data obtained during balloon flights near the equator. The instrument employed was a Cherenkov scintillation counter telescope, flown at an altitude of 6.7 g/cm^2 residual atmosphere from Hyderabad on April 20, 1965. The singly charged particles involved were protons, deuterons, antiprotons, re-entrant albedo electrons, and primary electrons. The results of antiparticle intensity measurements are shown in tabular form. The flux of antiparticles at the equator was calculated as 2.0 ± 7.9 particles/m^2/s/sr, while the return albedo flux was 13.9 ± 10.5. The ratio of antiprotons to all singly charged particles in the vertical direction was $(1.7 \pm 6.5) \times 10^{-2}$. (UK)

7573 27-DAY RECURRENCE AND LONG-TERM MODULATION OF COSMIC-RAY INTENSITY. Balasubrahmanyan, V. K. (Goddard Space Flight Center, Greenbelt, Md.); Venkatesan, D. Solar Phys.; 20: No. 1, 186-7(Oct 1971).

Lockwood (1971) has commented on an earlier paper by Balasubrahmanyan and Venkatesan (1970a). Here, it was thought relevant to comment on the general problem of the relationship of the 27-day recurrence and long-term modulation of cosmic-ray intensity with solar activity in the light of further work. (W.D.M.)

7574 COSMIC-RAY INTENSITY VARIATIONS IN ANTARCTICA. Pomerantz, Martin A.; Duggal, Shakti P. (Franklin Inst., Swarthmore, Pa.). Antarctic J. U. S.; 6: No. 5, 219-21(Sep-Oct 1971).

The control by the Sun over the flux of cosmic rays reaching the Earth is shown through its extension into space by way of the solar wind, preventing observations of the total intensity of particles originating outside the solar system even during the minimum phase of the 11-year solar cycle. Another manifestation is the acceleration of its own energetic particles that attain energies sufficient to propagate their effects to ground-based stations. Measurements of the cosmic-ray intensity were made at Bartol stations in the Antarctic and Thule in the Arctic regions during Jan. 1967 to Mar. 1971. Discoveries associated with the transient north–south asymmetry of galactic cosmic rays were made. The duration of the anisotropy was only a few hours and the north–south asymmetry can persist for as long as 6 days, a period equal to the extent of an interplanetary magnetic sector. A new type of event provides insight into the dynamics of the morphology of the interplanetary medium. An abnormal anisotropy during a solar-particle event regarding the propagation of solar cosmic rays shows itself as a 49% difference in the nucleonic intensity at the north and the south polar stations. (J.C.W.)

7575 SOLAR COSMIC-RAY EVENTS OF 1969 AND 1970. Masley, A. J.; Satterblom, P. R. (McDonnell Douglas Astronautics Co., Santa Monica, Calif.). Antarctic J. U. S.; 6: No. 5, 221-3(Sep-Oct 1971).

The polar-orbiting OGO-6 satellite was launched on June 5, 1969. Simultaneous observations of the Sept. 25 and Nov. 2, 1969 events were made by OGO-6 and ground-based polar equipment. The Sept. 25 event began at about 0800 UT, having only high-energy particles present with a subsequent classical buildup of the spectrum as lower energy particles arrived. A major flare occurred one day behind the west limb at 0943 UT on Nov. 2, 1969. The 14 solar cosmic-ray events of 1970 (compared to 21 during 1969) observed with riometer absorption greater than 0.4 dB at 30 MHz are listed. (J.C.W.)

7576 DIRECT MODE OF PROPAGATION OF COSMIC RAYS TO GEOSTATIONARY SATELLITES. Gall, Ruth (National Univ. of Mexico, Mexico City. Comision Nacional de Energia Nuclear, Mexico City); Smart, D. F.; Shea, M. A. Planet. Space Sci.; 19: No. 11, 1419-30(Nov 1971).

Synchronous orbit satellites offer a unique platform for both the detection of low-energy cosmic rays and the theoretical study of the effect of the magnetic fields in the outer magnetosphere on their propagation. Using a mathematical model of the magnetosphere, trajectories of low-energy cosmic rays arriving at the position of the ATS-1 synchronous orbit satellite were computed to determine the propagation characteristics. Analysis of these calculations leads to the determination of the geomagnetic cutoffs, the specific regions of penetration at the magnetospheric boundary, and the directions of approach from the interplanetary medium. For particles propagating by the direct mode without undergoing scattering, it is possible to uniquely relate directions of incidence at the satellite with the directions of approach at the magnetospheric boundary. It is also possible to specify measurable characteristics that permit the determination of whether or not radiation is propagating through the outer magnetosphere by the diffusive or by the direct mode of propagation. (auth)

7577 PRODUCTION OF THE ELEMENTS Li, Be, AND B BY GALACTIC COSMIC RAYS IN SPACE AND ITS RELATION WITH STELLAR OBSERVATIONS. Meneguzzi, M.; Audouze, J.; Reeves, H. (Service d'Electronique Physique, Saclay, France. Institut d'Astrophysique, Paris). Astron. Astrophys.; 15: No. 3, 337-59(Dec 1971).

The L-element (Li, Be, B) contamination rate of the interstellar gas by nuclear reactions induced by galactic cosmic rays (G.C.R.) was calculated using a diffusion model of fast moving particles in the Galaxy. The presence of helium in the G.C.R. flux and in the interstellar gas was taken into account. It was found that most of the stellar and meteoritic data is in agreement with a model which otherwise gives a reasonable account of the G.C.R. observations. This model assumes an injection spectrum in total energy power ($W^{-2.6}$) diffusing in a leaking galaxy with an escape range of 6.3 g cm^{-2}. The intensity, the composition at the source, and the spectral shape have remained the same for the last 10^{10} years. However a large part of the ^{7}Li must come from another source. Two possibilities are discussed: (a) thermonuclear ^{7}Li ejected from giant stars in "dirty" regions of the galaxy, and (b) spallative ^{7}Li generated from an intense low-energy component of the G.C.R. The relative merits of both hypotheses are discussed. (auth)

7578 PROCEEDINGS OF THE VI INTERAMERICAN SEMINAR ON COSMIC RAYS, LA PAZ, BOLIVIA, 19–24 JULY 1970. VOLUME I. Cuaderno No. 38. La Paz, Bolivia; Universidad Mayor de San Andres (1970). 303p. (In Spanish and English). (CONF-700708-(Vol.1)).

A separate abstract is included for each of the 23 papers in this volume. (J.C.W.)

For abstracts of individual papers see: 7390, 7391, 7437–7440, 7579–7594, and 7650.

7579 ORIGIN OF COSMIC RAYS. Hayakawa, Satio (Nagoya Univ., Japan). pp 1-28 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. I. La Paz, Bolivia; Univ. Mayor de San Andres (1970).
From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.1).

A review of recent investigations of the origin of cosmic rays is given under the light of new discoveries in high-energy astrophysics. By reference to a pulsar model by Ostriker and Gunn (1969), it is shown that particles accelerated by magnetic dipole radiation give an energy spectrum in agreement with that observed for galactic cosmic rays. The generation rate of low-energy cosmic rays from red dwarfs is estimated. Their contribution to galactic cosmic rays is considered to be minor if the ionization and heating of interstellar gas are caused by cosmic rays. Recent works on the propagation of cosmic rays are reviewed with reference to chemical composition, energy dependence, the electron spectrum, small anisotropy, and the distribution of gamma-ray intensity. A comment is made on the relation between chemical composition and cosmic-ray sources. Attention is given to the question of the existence of very-high-energy cosmic rays and strong microwave radiation. 14 references. (IAA)

7580 PROPAGATION OF COSMIC RAYS IN THE GALAXY. Cesarsky, Catherine J. (Harvard Coll. Observatory, Cambridge, Mass.). pp 29-38 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. I. La Paz, Bolivia; Univ. Mayor de San Andres (1970).
From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.1).

A study of the resonant interaction of cosmic rays with hydromagnetic waves of wavelength comparable to their Larmor radii was made. These waves are generated by the cosmic rays themselves when they exhibit streaming velocities in excess of the Alfvén velocity in the medium and are damped by the collisions between the charged and neutral particles in the interstellar medium. Thus, cosmic rays of energy less than 10 GeV may be responsible for their own confinement in the disk of the Galaxy. But the flux of cosmic rays of higher energy is too low, and external sources of turbulence are necessary. Interstellar clouds, and motions related to them, set up waves with wavelengths of the order of parsecs. Assuming that the Heisenberg theory applies to this form of turbulence, an attempt is made to determine whether this source is adequate for confining high-energy cosmic rays to the disk of the Galaxy. (auth) (IAA)

7581 DISCRETE SOURCES AND THE STATISTICS OF COSMIC-RAY PROPAGATION. Reames, D. V.; Ramaty, R. (Goddard Space Flight Center, Greenbelt, Md.). pp 39-49 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. I. La Paz, Bolivia; Univ. Mayor de San Andres (1970).
From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.1).

A model is considered in which cosmic rays diffuse from discrete sources whose spatial and temporal location is selected at random in the galactic disk. The anisotropy and age of various chemical constituents in the radiation are studied as a function of the scattering mean free path, λ, and a value of λ between 0.1 and 0.01 parsec is seen to be selected by comparison of the model with observations. Within this region, the effective age of the heavier components is primarily controlled by fragmentation rather than escape, and the bulk of their flux is contributed by a few local sources. The statistics of the source distribution lead to the prediction of large spatial and temporal fluctuations for these heavy components, although the protons vary by no more than about 20%. The effect of λ on the age or path-length distributions is considered. (auth) (IAA)

7582 SOME REMARKS ON THE COMPOSITION OF COSMIC RADIATION. Waddington, C. J. (Univ. of Minnesota, Minneapolis). pp 50-71 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. I. La Paz, Bolivia; Univ. Mayor de San Andres (1970).
From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.1).

The many violent and explosive events occuring in the Universe, which are enormously energetic, are considered. Cosmic-ray particles represent a sample of matter that has undergone processes that are comparatively common, although esoteric. It is suggested that the relative abundances of the various types of particles may indicate something about the nature of these processes and the characteristics of the regions in which they occur. (IAA)

7583 ORIGIN OF DIFFUSE SOFT X RAYS. Hayakawa, S.; Kato, T.; Makino, F.; (and others) (Nagoya Univ., Japan). pp 106-21 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. I. La Paz, Bolivia; Univ. Mayor de San Andres (1970).
From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.1).

It was observed that the diffuse component of cosmic soft x rays depends on the galactic latitude more weakly than expected from the interstellar absorption of extragalactic x rays. If this is interpreted in terms of the contribution of galactic soft x-ray sources, the emission rate of soft x rays in the galactic disk is of the order of 10^{-28} erg/cm^3/sec. As a possible candidate of the soft x-ray sources, flaring red-dwarf stars are suggested. (auth) (IAA)

7584 PRELIMINARY RESULTS ON GALACTIC DIFFUSE X-RAY MEASUREMENTS. Santochi, O. R.; Simerman, M. O.; Zelaya, M. A.; Manzano, J. R. (Univ. Nacional, Tucuman, Argentina). pp 122-30 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. I. La Paz, Bolivia; Univ. Mayor de San Andres (1970).
From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.1).

Measurements were made of galactic and albedo x rays by means of balloon-borne instruments and sounding rockets. The results of two flights made with the Argentine sounding rocket ORION II for the measurement of galactic diffuse x rays are given. They are in good agreement with those presented by Hudson et al. (1966). (IAA)

7585 DAY-TO-DAY MODULATION OF THE COSMIC-RAY ANISOTROPY. Barnden, L. R. (Univ. of Adelaide); McCracken, K. G. pp 148-58 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. I. La Paz, Bolivia; Univ. Mayor de San Andres (1970).
From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.1).

A discussion is given of the temporal variability of the cosmic-ray anisotropy in the energy range from 1 to 100 GeV. The role of abnormal cosmic-ray gradients in the production of enhanced anisotropies is stressed. A technique is outlined for the calculation of the diurnal variations produced by abnormal, ephemeral, or nonlinear cosmic-ray density gradients. This technique leads to the prediction of temporal variations at times near the onset of Forbush decreases that are in accord with observation. It is shown that abnormal density gradients such as are implied to accompany cosmic-ray modulation events predict changes in the diurnal phase and amplitude that are in general accord with observation. (auth) (IAA)

7586 RIGIDITY DEPENDENCE OF FORBUSH DECREASES AND 11-YEAR VARIATION IN COSMIC-RAY INTENSITY OBSERVED DURING THE CURRENT SOLAR ACTIVITY CYCLE. Mathews, T.; Stoker, P. H.; Wilson, B. G. (Univ. of Calgary, Alberta). pp 159-65 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. I. La Paz, Bolivia; Univ. Mayor de San Andres (1970).
From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.1).

Results of a comparative study of Forbush decreases and 11-year variations in cosmic-ray intensity observed at Calgary and Sulphur Mountain and at other neutron-monitor stations are presented. It was found that the same modulation function described the 11-year variation during the current solar cycle as the last solar cycle. While no definite difference between modulation functions applicable to the recovery phase of Forbush decreases and 11-year variation could be established, it was found that during the onset phase of Forbush decreases a modulation function of the form could not account for the decreases. (auth) (IAA)

7587 PRELIMINARY ANALYSIS OF THE COSMIC-RAY STORM OF JANUARY 26, 1968. Anda, R. (Univ. Mayor de

San Andres, La Paz, Bolivia). pp 166-75 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. I. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.1).

Preliminary analysis of a cosmic-ray storm on Jan. 26, 1968 shows the peculiarities of the enhanced daily variation and short-lived variation in this event. The distinct feature of this storm is that an apparently remarkable increase of cosmic-ray intensity follows the first decrease. The rise of the intensity is more rapid in high latitudes than in low latitudes, and a second decrease deeper than the first one follows the increase. (IAA)

7588 ANISOTROPY DURING THE ONSET OF THE COSMIC RADIATION FORBUSH DECREASE MODULATION MECHANISM. Manzano, J. R. (Univ. Nacional, Tucuman, Argentina); Ortiz de Adler, N.; Pasqualini de Bullaude, E. G.; (and others). pp 176-89 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. I. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.1).

Three Forbush decreases that occurred during 1958, 1961, and 1969 were analyzed for the behavior of an eventual anisotropy in the modulation mechanism for this type of process. The neutron-monitor data used were corrected for the daily-variation effect, and the onset times of the phenomena were calculated by the method of the regression-lines crossing. Both lines, the pre-storm and the decreasing phase, were fitted by minimum squares. This method allows a statistical estimation of the limits for the onset times. A verification of this starting time has been made with the method of accumulated sums of the corrected data, which would show a break at the beginning of the Forbush event. The results obtained show an evident anisotropy in the propagation of the perturbation for the three events analyzed. (auth) (IAA)

7589 GEOSTATIONARY SATELLITES AND ANISOTROPIES OF COSMIC-RAY PROPAGATION IN THE INTERPLANETARY MEDIUM. Bravo, Silvia; Gall, Ruth (Univ. Nacional Autonoma de Mexico, Mexico City). pp 190-7 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. I. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.1).

Studies were made of the propagation of cosmic-ray particles in a model magnetosphere. It is suggested that geostationary satellites be used in the detection of anisotropies of propagation of cosmic rays in the interplanetary medium. In particular, the anisotropies for which observation is suggested are the propagations along Parker's field lines. The suggestion is based on the idea that the direct mode of propagation operates in the magnetosphere, at least for energies above 50 MeV. (IAA)

7590 DIURNAL VARIATION OF INTENSITY OF NUCLEONIC COMPONENT OF COSMIC RADIATION DURING THE PERIOD 1959 TO 1965. Ragout, S.; Santochi, O. R.; Manzano, J. R.; Pasqualini, E. Gomez; Ortiz, N. (Univ. Nacional, Tucuman, Argentina). pp 198-217 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. I. La Paz, Bolivia; Univ. Mayor de San Andres (1970). (In Spanish).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.1).

Analysis of data from six stations of the diurnal variation of the intensity of cosmic radiation between the years 1959 to 1965 was made, relating this interval to a semiperiod of solar activity. A year-by-year harmonic analysis was made for five groups corresponding to growing geomagnetic activities. It appears that the mechanism of the simultaneous rotation of the particles with the solar magnetic field is very effective up to rigidities of the order of 2 BeV. (IAA)

7591 DIURNAL SOLAR VARIATION OF COSMIC RADIATION BASED ON DIRECTIONAL MEASUREMENTS OF MESONS. Heredia, H. F. (Univ. Nacional, Cordoba, Argentina). pp 218-22 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. I. La Paz, Bolivia; Univ. Mayor de San Andres (1970). (In Spanish).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.1).

Results of measurements are given of cosmic radiation recorded by meson-telescope systems from two Argentine stations, Buenos Aires and Ushuaia, during the period 1958 to 1961. The waves of the expected diurnal variations were calculated for specific directions at each station starting from an anisotropy in free space, independent of the rigidity, of amplitude 0.4% and 90° east of the Earth-Sun line. Comparison of observed and predicted results showed good agreement. (IAA)

7592 COSMIC RAY ANISOTROPIES PERPENDICULAR TO THE ECLIPTIC PLANE. Swinson, Derek B. (Univ. of New Mexico, Albuquerque). pp 223-30 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. I. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.1).

Three years of data from the Embudo (northern hemisphere) and one and one-half years of data from the Bolivia (southern hemisphere) underground muon telescopes were analyzed according to the field direction. Data from the Embudo vertical telescope are presented for May 1965 to Oct. 1968, displayed as harmonic dials in sidereal time, the data organized according to the direction of the interplanetary magnetic field. Data from the Bolivia telescope are from Jan. 1967 to May 1968. The results show that over a year, when both field directions occur with approximately equal frequency, an 18-hr sidereal time anisotropy in the northern hemisphere and a 6-hour sidereal time anisotropy in the southern hemisphere occur, and no appreciable resultant anisotropy at the equator occurs. In other experiments of sidereal anisotropies below about 100 GeV, the data have been interpreted as being due to a two-way sidereal anisotropy in the primary radiation in which there would be a maximum in the intensity of primary cosmic rays traveling both backward and forward along some fixed direction in the galaxy. It is suggested that the sidereal variation had its origin in a solar modulation mechanism. (J.C.W.)

7593 DETERMINATION OF AN ATMOSPHERIC ANOMALY IN THE CALCULATION OF THE BAROMETRIC COEFFICIENT OF THE SECONDARY COSMIC-RAY FLUX. Alvial C., Gabriel (Univ. Chile, Santiago de Chile). pp 273-6 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. I. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.1).

An estimated inversion of pressure at an altitude of between 800 and 700 millibars has now been shown from experiments of this anomaly. Corrections were made from data of the cubic plastic monitor counters at Los Cerrillos and the pressure data from El Infiernillo. The study of the determination of the atmospheric anomaly in the calculation of the barometric coefficient of the secondary cosmic-ray flux is the first of its kind. The anomaly refers to a dephasing between the pressure waves at the height of 4343 meters in the Andes and at 567 meters in Santiago, Chile; the higher altitude measurements from El Infiernillo and the lower altitude observations from Los Cerrillos. (J.C.W.)

7594 COSMIC-RAY ATMOSPHERIC NEUTRON MEASUREMENTS AT HIGH ELEVATIONS OVER A SUNSPOT CYCLE. Korff, Serge A.; Mendell, Rosalind B. (New York Univ., N. Y.). pp 277-82 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. I. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.1).

A series of measurements of the neutrons produced in the atmosphere by the cosmic radiation has been made. The measurement includes the energy spectrum of these neutrons in the energy-interval from 1 to 10 MeV. The measurements were made at far northern latitudes, at Fairbanks, Alaska, and at Churchill, Manitoba, Canada, using both airplanes and balloon-borne instruments. Substantial changes over the sunspot cycle have been noted. Rates of production of carbon 14 were estimated. (auth) (IAA)

7595 PROCEEDINGS OF THE VI INTERAMERICAN SEMINAR ON COSMIC RAYS, LA PAZ, BOLIVIA, 19-24 JULY 1970. VOLUME II. Cuaderno No. 39. La Paz, Bolivia; Universidad Mayor de San Andres (1970). 268p. (In Spanish and English). (CONF-700708-(Vol.2)).

A separate abstract is included for each of sixteen papers in this volume. One paper had appeared previously in NSA as NSA 25: 9253. (J.C.W.)

For abstracts of individual papers see: 6892, 6912, 7596-7608, and 7885.

7596 LIGHT FLASHES GENERATED BY PRIMARY COSMIC-RAY NUCLEI WITHIN THE EYES OF APOLLO ASTRONAUTS. Fazio, G. G. (Smithsonian Astrophysical Observatory, Cambridge, Mass.); Jelley, J. V.; Charman, W. N. pp 283-95 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. II. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.2).

Astronauts in the Command Modules of Apollos 11, 12, and 13 have recorded seeing flashes of light in their eyes. The phenomena occurred most frequently when the eyes were closed. It is suggested that these flashes arise from the primary cosmic radiation interacting directly with the ocular media or retina of the eye. Two mechanisms that have been proposed are Cherenkov radiation and direct excitation of the light receptors in the retina or their associated cells. All the observations were made in translunar flight. An experiment made in 1962 revealed that there is some evidence that sea-level cosmic-ray particles can be detected by dark-adapted observers under good conditions. (J.C.W.)

7597 PROPOSAL ON THE CONTINUOUS OBSERVATION OF SMALL SHOWERS. Murakami, K.; Kawasaki, S. (Inst. of Physical and Chemical Research, Tokyo). pp 296-302 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. II. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.2).

There is no sufficient experimental data to establish the feature of anisotropy in sidereal time for high-energy primary cosmic rays. Observations of air showers around the size of 10^4 are needed. Heretofore, such small showers have been detected without information on the incident direction because it is expected that most of these showers come near the vertical direction at lower altitudes. The measurement of small showers with the selection of several incident directions is discussed. The observations on the sidereal anisotropies of galactic cosmic rays have been carried out over almost the whole range of cosmic-ray energy, but observational data are missing in the energy region from 10^{12} to 10^{14} eV. An air shower of about 10^4 corresponds to primary energy of 10^{13} to 10^{14} and most data of such showers have been done without the selection of their arrival directions, because of too-low particle density. The method of directional detection for the small showers is discussed and includes the plastic scintillator, water Cherenkov detector, resonant transition radiation detector, and the modified GM counter. (J.C.W.)

7598 VARIATION OF THE EFFICIENCY OF PLASTIC SCINTILLATION COUNTERS AS FUNCTION OF TEMPERATURE IN MEASURING THE SECONDARY COSMIC-RAY FLUX. Alvial, Gabriel (Univ. Chile, Santiago de Chile). pp 316-26 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. II. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.2).

An experiment is described for studying the statistical correlation between the variations of the measurements of the flux of secondary cosmic radiations and those of pressure and temperature. A notable correlation was observed between the variations of the temperature of the laboratory and the variations of the measurements of the flux of ionizing particles of the cosmic radiation carried out with a cubic monitor of plastic counters of scintillation, housed in the Los Cerrillos station. To calculate the coefficient of the temperature of the plastic, a conventional definition of isomorphic atmosphere is used in order to take into consideration pressure effects. This coefficient has resulted negative between 20 and 40°C and shows some odd thousandths/°C and increases its relative value if the energy of the particles detected themselves decrease. (J.C.W.)

7599 BRITISH LARGE AIR SHOWER PROJECT AT HAVERAH PARK, NEAR LEEDS. Wilson, J. G. (Univ. of Leeds, Eng.). pp 393-426 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. II. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.2).

A description is given of the characteristics of and measurements made by the Haverah Park array. This single-cell array consists of more than 200 standard detector units set out in a complex grouping over an area of about 12 km². The main Cherenkov system has been used as a device for identifying in maximum detail individual air showers in order to provide information to which observations in auxiliary supporting experiments could be related. The inner array of Cherenkov detectors, which has been in operation for over seven years, provides data on showers the majority of which fall into a relatively small energy range. Current problems of Haverah Park and of other large shower arrays are discussed. (IAA)

7600 ZENITH-ANGLE DISTRIBUTION OF HORIZONTAL AIR SHOWERS. Boehm, E.; Fritze, R.; Hoffmann, H. P.; (and others) (Univ., Kiel). pp 427-34 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. II. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.2).

Recording of air showers with zenith angles larger than 60° has been continued using the horizontal air-shower array at Kiel. By means of crucial selection criteria, horizontal showers have been separated from background events. The resulting zenith-angle distribution shows some evidence for an isotropic distribution. No attempts have been made to derive an absolute shower size spectrum of horizontal air showers. (auth) (IAA)

7601 STUDIES ON TeV HADRONS IN AIR SHOWER CORES AT SEA LEVEL AND AT MOUNTAIN ALTITUDE. Fritze, R. (Univ., Kiel); van Staa, R.; Truemper, J.; (and others). pp 435-45 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. II. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.2).

Results on the energy and lateral distributions of TeV hadrons in air shower cores obtained by means of the Kiel 14-mm² shielded neon hodoscope are summarized, and the bearing of this information on the characteristics of high-energy collisions and the chemical composition of the primary cosmic radiation is discussed. In addition to the sea-level experiment at Kiel, a similar apparatus is under construction on the Pic-du-Midi (730 g/sq cm). (auth) (IAA)

7602 EXTENSIVE AIR SHOWER SIMULATION. Capdevielle, Jean-Noeel; Dupuy, Jean; Cachon, Andre (Observatoire du Pic du Midi, Bagneres-de-Bigorre, France). pp 446-70 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. II. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.2).

A method was described to reconstitute all the effects generated by one particle of primary energy between 10^{10} and 10^{20} eV penetrating the atmosphere or any other medium (planetary atmospheres, intersidereal clouds, intragalactic matter, liquids, solids). The primary-particle axis is assumed to be vertical (but any zenithal direction can be used in the calculations). For each primary energy, nine nuclear-interaction types associated with nine combinations permit reconstitution of nine different EAS. (J.C.W.)

7603 COMPARISON OF SOME RESULTS OF AIR SHOWER THEORY WITH EMPIRICAL DATA. Thielheim, K. O.; Beiersdorf, R. (Univ., Kiel). pp 479-91 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. II. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.2).

Results of three-dimensional Monte Carlo simulations of extensive air-shower development are presented. The theoretical results, which were obtained using the modified version of the CKP-model (Thielheim and Beiersdorf, 1969, 1970), are compared with empirical data. The results show fair agreement when referred to measurements at sea level. It is shown that the calculated lateral distribution of hadronic energy is also in good agreement with empirical results from sea-level measurements. (IAA)

7604 EXTENSIVE AIR SHOWER RADIO OBSERVATIONS IN BRITAIN AND IRELAND. Jelley, J. V. (Atomic Energy Research Establishment, Harwell, Eng.). pp 492-503 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. II. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.2).

The progress of work on EAS radio emissions from 1964 to 1970 in Britain and Ireland is covered. One area of study is the radiation physics involving the radiation mechanisms and the relation of this radiation to the various features of the showers. Another study has been concentrated on attempts to detect showers by wholly radio methods. The experimental results include data on lateral distribution, frequency spectrum, polarization, radio energy vs shower energy, zenith-angle dependence, and coherent vs incoherent radiation. An expression is given for the radio emission from a cosmic shower that is used for calculations in the two countries. Three mechanisms have been proposed at Harwell by which the Earth's vertical electric field gradient might be invoked to generate radio pulses, from both vertical and horizontal EAS. (J.C.W.)

7605 COINCIDENT RADIO PULSES. Hazen, W. E.; Hendel, A. Z.; Smith, Howard; Castle, R. J. (Univ. of Michigan, Ann Arbor). pp 504-14 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. II. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.2).

An array of five antennas was triggered whenever there was a coincidence of radio pulses in three antennas. Suitable delays aimed the antennas electronically at a point near the horizon and in a second run at a zenith angle of 45°. Arrival directions of the radio fronts were computed from pulse arrival times in two different sets of three antennas and there was good agreement between them. The events cannot be due to chance coincidence but there is no evidence that they were produced by air showers. (auth) (IAA)

7606 SIMULTANEOUS OBSERVATION AT THREE FREQUENCIES OF RADIO PULSES AT CHACALTAYA. Hazen, W. E.; Hendel, A. Z.; Smith, Howard (Univ. of Michigan, Ann Arbor). pp 515-19 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. II. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.2).

During the period Nov. 26, 1969 to Jan. 18, 1970, part of the radio equipment at Mt. Chacaltaya was used for a preliminary attempt to measure the spectra of radio pulses associated with EAS. Three narrow-band ($3\frac{1}{2}$ MHz) channels were coupled to a single wide-band antenna and amplifier chain. Pulses were observed in all three channels (57, 85, and 177 MHz). For showers arriving within about 30° of the antenna axis, the spectral index for the two lower frequencies is 1.2 ± 0.4. (J.C.W.)

7607 LATERAL DISTRIBUTION OF RADIO PULSES AT CHACALTAYA. Hazen, W. E.; Hendel, A. Z.; Smith, H.; Shah, J. (Univ. of Michigan, Ann Arbor). pp 520-6 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. II. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.2).

Radio pulses were recorded in seven antennas, two of which were more than 100 meters from the remaining cluster of five antennas. Of 77 showers with pulses in three or more antennas, 44 had pulses in one or both distant antennas. The probability of observing a pulse in a distant antenna increases with its decreasing distance from the shower core as $e^{-r/120}$, and is proportional to the zenith angle of the shower. It is independent of the shower size. (auth)

7608 MECHANISMS FOR RADIO SIGNALS ASSOCIATED WITH EXTENSIVE AIR SHOWERS. Hough, J. H.; Prescott, J. R. (Univ. of Calgary, Alberta). pp 527-36 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. II. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.2).

Measurements in both north—south and east—west polarizations of 22-MHz radio signals associated with EAS of mean size about 10^6 confirm the major role played by charge separation in the Earth's magnetic field in generating these signals up to axial distances of about 150 m. In this range of distances, there is evidence for a 15% contribution of nongeomagnetic origin. (auth) (IAA)

7609 PROCEEDINGS OF THE VI INTERAMERICAN SEMINAR ON COSMIC RAYS, LA PAZ, BOLIVIA, 19-24 JULY 1970. VOLUME IV. Cuaderno No. 41. La Paz, Bolivia; Universidad Mayor de San Andres (1970). 223p. (In Spanish and English). (CONF-700708-(Vol.4)).

A separate abstract is included for each of eleven papers in this volume. One paper has appeared previously in NSA 25: 7195. (J.C.W.)

For abstracts of individual papers see: 7610—7619 and 7785.

7610 COMMENT ON THE REVIEW PAPER "MUONS AND NEUTRINOS" BY M. G. K. MENON. Maeda, Kaichi (Goddard Space Flight Center, Greenbelt, Md.). pp 831-2 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. IV. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.4).

An explanation was given of the lowered vertical intensity of muons at a given depth calculated from the Utah data of H. E. Bergeson et al., 1967, and J. W. Keuffel et al., 1969. Consequently, the enhancement factor of muon intensity with zenith angle Θ, $G(h,\Theta) = I(h,\Theta)/I_v(h)$ is slightly larger than the values that can be expected from Prof. Menon's vertical intensity curve. The analysis of the author has been revised by Kitamura and Kobayakawa and they also show that the large enhancement factor G(h,Θ), of Kolar data can be brought into agreement with that of the Utah data. (J.C.W.)

7611 ZENITHAL DISTRIBUTION OF ATMOSPHERIC MUONS AT MT. CHALCALTAYA. Maeda, Kaichi (Goddard Space Flight Center, Greenbelt, Md.). pp 847-912 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. IV. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.4).

The objective of the investigations discussed was to test the new process for energetic-muon production in the atmosphere proposed by Keuffel, et al. (1959) and Bergeson, et al. (1968). The zenith-angle distributions of atmospheric muons were calculated for the altitude of 5200 m above sea level, taking into account an energy range from 100 GeV to 100 TeV and zenith angles from 0 to 92.3°. Calculations are based on the extension of the Chapman function to the case of a nonisothermal atmosphere. The energy-dependent nuclear-interaction mean free path of cosmic-ray hadrons in air, different magnitudes of photonuclear cross section in the energy-loss process of muons in the atmosphere, contributions of atmospheric muons arriving below the horizontal directions, and atmospheric structure and geomagnetic deflection are considered. Results are compared with those corresponding to sea level. (IAA)

7612 EMPIRICAL ASPECTS OF MUON SHOWERS UNDERGROUND. Stenerson, R. O.; Coats, R. B.; Cannon, T. M.; Ingebretsen, R. B. (Univ. of Utah, Salt Lake City). pp 913-29 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. IV. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.4).

A sample of over 100,000 events corresponding to primary cosmic-ray energies greater than 10 TeV were analyzed to determine the energy and angular dependence of muon intensities underground. These results, together with earlier measurements of the counting rates of more than 5000 pairs of muons as a function of their separation, form the basis of a qualitative understanding of muon showers. The rates of muon pairs have an almost exponential dependence on pair separation. The relative attenuation of single muons and pairs with rock depth is quite similar. (IAA)

7613 MOMENTUM SPECTRA OF COSMIC-RAY PARTICLES AT SEA LEVEL IN MOMENTUM RANGE 0.05 TO 6 GeV/c. Allkofer, O. C.; Clausen, K.; Knoblich, P. (Univ., Kiel). pp 930-6 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. IV. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.4).

The equipment used in the investigations consisted of a magnetic spark-chamber spectrograph and an ionization calorimeter. The scintillation counters of the calorimeter were connected to 9 four-channel pulse-height analyzers. Using the relations for range, ionization loss, EM, and nuclear cascade development, the particle mode could be determined by pulse-height analysis. A table with the measured intensities of positive and negative muons is presented, and measured intensities and charge ratio of the electrons are shown. (IAA)

7614 MUON FLUX OF COSMIC RAYS AT 1 GeV/c. Allkofer, O. C.; Dau, W. D.; Jokisch, H. (Univ., Kiel). pp 937-48 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. IV. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.4).

The measurements were conducted because of discrepancies that appeared when different normalized spectra were compared with absolutely measured spectra. The differential intensity obtained is about 26% higher than the value generally used as normalization point for muon spectra. Allowance was made for showers, and aspects of multiple scattering, straggling, zigzag motion, efficiency of the detectors, and the dead time of the electronic equipment were taken into consideration. (IAA)

7615 SEA-LEVEL MUON SPECTRA AT 83^0 ZENITH ANGLE UP TO 1 TeV. Allkofer, O. C.; Carstensen, K.; Dau, W. D.; (and others) (Univ., Kiel). pp 949-59 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. IV. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.4).

The muon spectrum at sea level was measured at a zenith angle of 83° in the momentum range 30 to 1000 GeV/c with the Kiel cosmic-ray spectrometer. The horizontal integral intensity is higher than the vertical one beyond about 100 GeV/c. (auth) (IAA)

7616 MUON SPECTRUM MEASUREMENTS AT 80^0 TO THE VERTICAL UP TO 1 TeV. Flint, R. W.; Nash, W. F. (Univ. of

Nottingham, Eng.). pp 960-85 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. IV. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708–(Vol.4).

Measurements are given of the muon sea-level spectrum at 80° to the vertical up to 1 TeV with the Nottingham 80° spectrometer. Over 25,000 single-particle events were analyzed. Comparison of the intensities at 80° with those in the vertical direction indicate no deviation from the sec Θ enhancement expected for kaon or pion parentage of the muons. The data were also used to study the variation of charge ratio over the same energy range. A possible fall in the charge ratio is apparent at 1 TeV. (auth) (IAA)

7617 INTERPRETATION OF MUON SPECTRA. Frohlich, A. (Tel-Aviv Univ., Israel); Leeman, S.; Widder, M.; Yeivin, Y. pp 987-1004 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. IV. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708–(Vol.4).

The examination of the muon spectra and charge ratios at sea level by means of a relatively simple collision model and the one-dimensional diffusion equation is described. The model consists of a constant power law for the energy dependence of the average multiplicity of secondary charged mesons, and constant kaon-to-pion ratio and inelasticity. The muon spectra is derived from this, and the charge ratio derivation requires an additional assumption relating to the net charge transferred to the kaons produced in a single collision. (J.C.W.)

7618 FLUX AND NUCLEAR INTERACTION PROPERTIES OF COSMIC-RAY PARTICLES UNDERGROUND. Cottrell, D. M. (Univ. of California, San Diego); Piserchio, R. J.; Thompson, Richard L.; Lord, J. J. pp 1019-28 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. IV. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708–(Vol.4).

Observations with nuclear emulsions were made of the flux and nuclear interaction properties of underground cosmic-ray particles to depths of 7800 grams/sq cm of standard rock. The integral sea-level energy spectrum was determined from the variation of flux as a function of range of particles in rock. While reasonable agreement with the standard spectrum was found for energies in excess of 50 GeV, the flux above 5 GeV was nearly 60% higher. The total inelastic nuclear cross section was measured for average particle energies up to 35 GeV. Comparisons of theory with experimental cross sections from 1 GeV to 100,000 GeV showed agreement to no better than a factor of two. Differential cross sections as a function of angle showed even less agreement with theory. Observations of particles at zenith angles of 30 to 50° showed anomalies in both the flux and cross section. (auth) (IAA)

7619 PRODUCTION OF MUONS BY THE NEUTRAL COMPONENT OF THE COSMIC RADIATION UNDERGROUND. Barton, J. C.; Betts, J. P.; Pourgourides, C. M. (Northern Polytechnic, London). pp 1029-36 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. IV. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708–(Vol.4).

An anticoincidence arrangement, installed in the Holborn Underground Laboratory at a depth of 61.3 hg cm^{-2} below sea level, screens a volume of 78 liters of liquid scintillator. The apparatus has an anticoincidence efficiency for muons better than 99.999% and has been used to investigate the production of low-energy muons by neutral components of the underground cosmic radiation. Only 8 events were observed during an operating time of 1100 hours, and these might well be attributed to spurious effects. The calculated flux cross-section product for the postulated process is certainly less than 3×10^{-36} sec^{-1} sr^{-1} $nucleon^{-1}$, a value three orders of magnitude less than that reported by Cowan. (auth) (IAA)

Direct Energy Conversion

Refer also to abstract 8427.

7620 NEW ENERGY-CONVERSION DEVICES BASED ON NERNST AND ETTINGSHAUSEN EFFECTS. Goldsmid, H. J. (Univ. of New South Wales, Kensington, Australia). Aust. Phys.; 8: No. 10, 143-6(Oct 1971).

A brief outline of the principles of selection of thermomagnetic materials is given. Alternative origins of thermomagnetic effects and their application to thermal radiation detectors and to direct current transformers are described. Among the latter is a hybrid transformer which consists of a thermocouple or thermopile primary and a thermomagnetic secondary. The temperature difference is produced by the Peltier effect and the Nernst effect gives output emf. (Australia)

7621 THERMOELECTRIC GENERATOR. Debiesse, Jean; Klein, Siegfried; Lipskier, Marcel; Sorriaux, Andre (to Commissariat a l'Energie Atomique). French Patent 2,061,924. 1 Jun 1971. Filed 2 Oct 1969. (In French).

A thermoelectric generator, designed to be used inside a nuclear reactor, is described. Its thermoelements consist of pellets of a P-type semiconductor (composed of fissile material, such as enriched uranium oxide) and metallic semiconducting pellets of an N-type material. The metal must possess an electrical/thermal conductivity ratio, which is as large as possible, and a neutron absorption cross section, which is as small as possible (Inconel alloy, zirconium-based alloys, and Zircaloy). (France)

7622 THERMOELECTRIC GENERATOR. (to Licentia Patent-Verwaltungs GmbH). British Patent 1,253,558. 17 Nov 1971. Priority date 21 May 1968, Germany.

The thermoelectric generator described contains a cooling device and a supporting plate, at the under side of which are mounted thermocouples, and perpendicular to the upper side there are cooling vanes mounted parallel to the end faces that project laterally beyond the supporting plate. (M.H.R.)

7623 THERMOELECTRIC GENERATOR. (to RCA Corp.). British Patent 1,253,754. 17 Nov 1971. Priority date 21 Jun 1968, United States.

The thermoelectric generator described contains a plurality of thermoelements assembled with interconnecting coupling straps in an annular assembly disposed between inner and outer casings. These casings are so constituted and radially dimensioned relative to the assembly as to subject it to radial compression at least at the operating temperature of the generator. Pressure contact between the thermoelements and coupling straps is established by this compression. (M.H.R.)

Fluid Physics

Refer also to abstract 7373.

7624 (UCRL–51103) ALTERNATING-DIRECTION IMPLICIT NUMERICAL SOLUTION OF TIME-DEPENDENT, TWO-DIMENSIONAL, TWO-FLUID MAGNETOHYDRODYNAMIC EQUATIONS. Lindemuth, Irvin R. (California Univ., Livermore. Lawrence Livermore Lab.). 5 Aug 1971. Contract W-7405-eng-48. 189p. Dep. NTIS.

A very general method for numerically solving two-dimensional, two-fluid magnetohydrodynamic equations is presented. The method uses alternating-direction implicit (ADI) finite-difference equations that are second-order accurate. The accuracy and implicitness of the resultant computer codes are features not available in previously reported codes. In this investigation the ADI method is applied to studies of the dynamics of a theta pinch and the trapping and thermalization of a laser-produced plasma expanding into a magnetic field. For the theta pinch, the effect of heat flow parallel to the magnetic field and the effect of axial motion are demonstrated. For the laser-produced plasma, the formation and persistence of the high-temperature shell observed in experiments is explained, and a bounce radius and time are predicted at which plasma motion across the magnetic field ceases. The calculations reported display very strong two-dimensional phenomena which cannot be demonstrated by the one-dimensional approaches to the same problems. For all calculations, the implicitness of the method leads to enhanced numerical stability; the calculations were done with time steps much larger than would be permissible with codes using explicit finite-difference equations so that a significant reduction in computer operating time was obtained. (auth)

7625 OSCILLATORY FLOW OF A CONDUCTING FLUID BETWEEN TWO NONCONDUCTING POROUS PLATES IN THE PRESENCE OF A TRANSVERSE MAGNETIC FIELD. Dube, S. K. Boll. Unione Mat. Ital.; 3: 599-606(Aug 1970).

An analysis was made of an oscillatory laminar flow of a viscous incompressible and electrically conducting fluid between two parallel nonconducting and nonmagnetic infinite porous flat plates subjected to a constant suction in the presence of uniform transverse magnetic field. Expressions for velocity, induced magnetic field, and skin friction are obtained when the magnetic Prandtl number is unity. The particular case of no suction is studied in detail. (IAA)

7626 UNSTEADY HYDROMAGNETIC FREE CONVECTION PAST A VERTICAL FLAT PLATE. Pop, Ioan (Univ., Cluj). Indian J. Phys.; 44: No. 3, 194-7(Mar 1970).

Unsteady-boundary-layer equations for an electrically conducting fluid moving past a semi-infinite vertical flat plate in the presence of a uniform transverse magnetic are investigated, when the plate temperature varies suddenly in time. Expressions for the velocity and temperature distributions are derived in the nondimensional forms. It is found that the skin friction decreases with increase in magnetic field. (auth)

7627 EFFECTS OF EXTERNAL CIRCUIT ON HEAT TRANSFER IN MHD CHANNEL FLOW. Soundalgekar, V. M. (Indian Inst. of Tech., Bombay); Rao, B. V.; Haldavnekar, D. D.; Iyer, R. S. Indian J. Phys.; 44: No. 3, 172-87(Mar 1970).

Heat transfer in fully developed MHD channel flow is analyzed. Closed-form solutions in cases of (i) two plates at constant temperatures and (ii) linear variation of temperature along the plates are derived for temperature, Nusselt number, mean-mixed temperature, and the difference between the wall temperature and the mean fluid temperature. Numerical values of the Nusselt number and mean-mixed temperature are entered in tables, whereas others are shown graphically. The effects of different parameters in different types of channel flows are discussed. (auth)

7628 HYDROMAGNETIC FLOW IN A POROUS DUCT. Govindarajulu, T. (Annamalai Univ., Annamalainagar, India). Proc. Indian Acad. Sci., Sect. A; 74: No. 2, 83-90(Aug 1971).

The steady flow of conducting fluid in a duct in the form of an annular sector with impressed fields in the circular and radial directions was studied, taking into account the porosity of the walls normal to the applied field. Exact solutions were obtained for insulating-wall conditions. (M.H.R.)

7629 MAGNETOHYDRODYNAMIC STABILITY IN THE LOW-PRESSURE LIMIT. Spies, G. O. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Z. Naturforsch.; 26a: No. 9, 1524-7(Sep 1971).

The stability of arbitrary toroidal magnetohydrostatic equilibria is investigated near the limit of a vacuum magnetic field. Nonsingular expansions in powers of $\beta \sim p/B^2$ are considered to all orders. Order-by-order minimization of the energy variation shows that any orders are positive semidefinite in the null space of all lower orders if either the vacuum field has shear or (for an identically vanishing rotational number) the interchange stability condition is satisfied. The question of sufficiency for stability at low β of these conditions is discussed. While sufficiency of shear can be refuted by considering localized modes, this question remains open for the interchange stability condition. (auth)

7630 TURBULENT FLOW OF AN ELECTRICALLY CONDUCTING FLUID DRIVEN BY THE UNIFORM ROTATION OF THE WALLS OF AN ANNULAR VESSEL IN AN AXIAL MAGNETIC FIELD, THEORETICAL STUDY FOR VARIOUS BOUNDARY CONDITIONS. Bendaoud, Mohamed; Vives, Charles (Algiers Univ.). Compt. Rend., Ser. A; 273: No. 14, 642-5(4 Oct 1971). (In French).

The flow of an electrically conducting fluid driven by the uniform rotation of the insulating walls of an annular vessel in an axial magnetic field is theoretically studied. It is demonstrated that the motion of the liquid can be accelerated or attenuated according to the boundary conditions. Theoretical diagrams for the changes in the local and mean velocities are given for the various fundamental parameters. (France)

7631 MAGNITNAYA GIDRODINAMIKA NESZHIMAEMYKH SRED. (Magnetohydrodynamics of Incompressible Media). Branover, G. G.; Tsinober, A. B. Moscow; Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Matematicheskoi Literatury (1970). 380p.

The following chapters are included: (1) basic effects caused by magnetic fields, (2) linear MHD flow in pipes, (3) instability of laminar flow and transition to turbulence in magnetic fields, (4) turbulent flows in pipes in magnetic fields, (5) specifics of MHD flow around bodies, (6) MHD Stokes and Oseen flows, (7) MHD boundary layer, (8) theory of MHD flow around bodies, (9) experiments on MHD flow around bodies, and (10) streams in a magnetic field. (M.O.W.)

Upper Atmosphere Physics

Refer also to abstracts 7377 and 7576.

7632 WHISTLERS CHANGE VLF SIGNAL AMPLITUDES. Helliwell, R. A. (Stanford Univ., Palo Alto, Calif.). Antarctic J. U. S.; 6: No. 5, 221(Sep-Oct 1971).

Observations during 200 events have shown that a whistler was present at the exact time a vlf signal amplitude began to change. Characteristics of the events are (1) a triggered vlf emission is sometimes associated with the whistler; (2) the change in vlf signal amplitude is usually about 6 decibels; (3) there are as many as 20 events over a period of 6 hours; (4) the vlf signal amplitude suddenly changes to a new level and then takes several tens of seconds to return to its pre-whistler level; and (5) riometer data for some of the events show absorption of 1 to 2 decibels. The correlation between vlf signal intensity anomalies and absorption suggests that the two are a result of electron precipitation and, even more striking, that electron precipitation is caused by whistlers. (J.C.W.)

7633 AURORAS OVER THE SOUTH POLE AND INTERPLANETARY MAGNETIC FIELD CHANGES. Akasofu, S.-I. (Univ. of Alaska, College). Antarctic J. U. S.; 6: No. 5, 223-4 (Sep-Oct 1971).

The mechanisms that control auroral activity, particularly auroral substorms, were investigated. It has been inferred that the southward-directed component of the interplanetary magnetic field causes the growth of auroral substorms. The study was made at the South-Pole station without the hindrance of sunlight, since it is located near or under the auroral oval for most of the day. The responses of auroras to change in interplanetary magnetic fields were observed. The sudden activation of an aurora over the South Pole was associated with the turning of the interplanetary magnetic-field vectors from the northward to the southward direction; the auroras were suddenly activated at about the time of the turning after a prolonged period of northward-directed interplanetary field during which auroras were quiescent and very faint. South-Pole all-sky photographs from orbiting satellites were also studied. (J.C.W.)

7634 CONJUGATE-POINT AURORAL STUDIES AT BYRD AND GREAT WHALE STATIONS, 1970. Millman, Peter M. (National Research Council of Canada, Ottawa). Antarctic J. U. S.; 6: No. 5, 224-5(Sep-Oct 1971).

Data from the conjugate-point stations at Bryd and Great Whale Geophysical Station have been used since 1966 to study auroral phenomena. During the austral winter of 1970 identical auroral photometers were operated at the two stations to measure relative intensity of auroral emissions at 5577, 4861, and 3914 A. In 1970, two all-sky cameras, one using color film and one using black film, were operated at both stations. Preliminary results from the experiments are presented. (J.C.W.)

7635 AIRBORNE CONJUGATE AURORAL STUDIES. Stenbaek-Nielsen, H. C. (Univ. of Alaska, College); Wescott, Eugene M.; Peterson, Robert W. Antarctic J. U. S.; 6: No. 5, 225-6 (Sep-Oct 1971).

Aircraft have been flown on conjugate paths south of New Zealand toward Antarctica and over Alaska. All-sky camera data have shown that auroras observed during low geomagnetic activity are conjugate. Data from a period during medium geomagnetic activity reveal that auroras observed in the region of the hydrogen arc remain conjugate, similarities may be found in the poleward auroral forms, but similar forms are displaced up to several hundred kilometers. An airborne investigation of the direction of the displacement of the auroral forms observed in the fall does not indicate a seasonal effect, suggesting that the wandering of the conjugate points is mainly substorm-dependent. Fall data were taken during morning hours and spring data during evening hours. All data show that the auroras over Alaska are brighter than those south of New Zealand, thus indicating a hemispherical asymmetry in particle precipitation. The intensity difference may be related to the difference in the magnetic-field strength along the flight path between the two hemispheres, indicating that the present concept of auroral morphology may have to be revised. (J.C.W.)

7636 MICROPULSATIONS AT GEOMAGNETIC POLES. Hessler, V. P. (Univ. of Alaska, College); Heacock, R. R.; Troitskaya, V. A. Antarctic J. U. S.; 6: No. 5, 226-7(Sep-Oct 1971).

Data from the Vostok and Qanaq, Greenland stations were used to investigate micropulsations at geomagnetic poles. One event shows a Pi burst followed by the rising frequency IPDP event and is typical of auroral-oval activity as observed in Alaska and Finland, but rarely observed in geomagnetic pole data, and it was not observed at this time at the auroral oval. Several unusually large-amplitude, structured Pc1 events were registered at Vostok during 1969 and 1970 and are being studied to determine the polarization characteristics, as observed on the ground, for waves propagating in the ionosphere's horizontal wave duct to the Pole. The incidence and amplitude of Pc3 regular pulsations 10 to 45 seconds long are being studied. Preliminary results show that the activity occurs during the day, shortly before geomagnetic noon, corresponding to the usual auroral-zone and middle-latitude distribution. A marked seasonal variation in amplitude and frequency is observed. (J.C.W.)

7637 WOULD SHOWER CORES OR RELATIVISTIC MONOPOLES PRODUCE STRAIGHT LIGHTNING? Tompkins, Donald R. Jr. (Univ. of Wyoming, Laramie). Phys. Rev., D; 4: No. 5, 1268-74(1 Sep 1971).

Can the atmosphere below thunderclouds act as a giant spark chamber for the detection of ultrahigh-energy shower cores or relativistic monopoles? The return stroke of ordinary lightning is crooked because the stepped leader is crooked and changes direction at most steps. In multiple strokes the subsequent strokes are preceded by a leader following the ionization channel of the previous return stroke. The cause of leaders occasionally leaving old stroke channels is found to be atomic and molecular negative ions inside and outside old stroke channels, respectively. It is shown that the ionization in shower cores and possibly that in monopole paths would be capable of carrying a lightning leader which would then be straight and result in a straight return stroke. It is shown that radio emission plus shower counter data may be able to answer whether the ionization from a shower core or relativistic monopole initiates a lightning leader. Artificial initiation of lightning shows that even thunderclouds without spontaneous lightning maintain large potential gradients over large areas for significant periods of time. Straight lightning may lack the normal preleader radio emission of spontaneous lightning. Thundercloud conditions for straight lightning may be more favorable over ocean than land areas. (auth)

7638 DISAPPEARANCE OF EQUATORIAL E_s AND REVERSAL OF ELECTROJET CURRENT. Rastogi, R. G.; Chandra, H.; Chakravarty, S. C. (Physical Research Lab., Ahmedabad, India). Proc. Indian Acad. Sci., Sect. A; 74: No. 2, 62-7(Aug 1971).

Based on simultaneous observations of the horizontal geomagnetic field component H, sporadic $E(E_s)$ and E−W electron drifts at stations close to the dip equator within the equatorial electrojet region on quiet days and sometimes on disturbed days, when there is an abnormal large decrease in H during daytime, there is a simultaneous disappearance of E_s and a reversal of the direction of drift of electrons from westward to eastward. This suggests that the disappearance of equatorial E_s during daytime is due to a temporary reversal of the electrojet current, which is caused by the imposition of an additional electrostatic field opposite in direction to that of normal S_q field. (auth)

7639 SOLAR-WIND-INDUCED MASS LOSS FROM MAGNETIC FIELD-FREE PLANETS. Curtis Michel, F. (Rice Univ., Houston, Tex.). Planet. Space Sci.; 19: No. 11, 1580-3 (Nov 1971).

The amount of atmospheric matter which can be carried away by the solar wind is estimated, the discussion being restricted to those planets whose atmosphere is not shielded by a strong magnetic field, as is the Earth's, from direct interaction with the Solar wind. (UK)

7640 SIMILARITIES BETWEEN SATELLITE OZONE CONTOURS AND MAGNETIC L-SHELL CONFIGURATIONS. Bowers, B. C. (Australian Defence Scientific Service, Salisbury). Planet. Space Sci.; 19: No. 11, 1583-5(Nov 1971).

Global ozone contours derived from COSMOS 65 are shown and these bear some resemblance to the geomagnetic L-shell contours at 100 km, also shown, except in the region of the South Pacific where there is an area of depletion. It has been suggested (Iozenas and Krasnopolsky, 1970) that this depletion was due to a geomagnetic storm. The similarities between the undisturbed ozone contours and the configuration of the L shells are noted, and the possible mechanisms that could lead to ozone depletion are discussed. (UK)

7641 LATITUDINAL VARIATION OF COSMIC-NOISE ABSORPTION. Sarma, S. B. S. S.; Sharma, M. C. (National Physical Lab., New Delhi). Planet. Space Sci.; 19: No. 11, 1579-80(Nov 1971).

The latitudinal variation of A_2 absorption was studied by the riometer technique using all available data, mostly for sunspot minimum at equinox (March−April 1964), from a number of stations distributed over a wide range of geomagnetic latitudes. The data indicate that as one approaches the equator the cosmic-noise absorption is greatly increased. (UK)

7642 ROCKET OBSERVATION OF VLF HISS IN AURORA. Ungstrup, Eigil (Danish Space Research Inst., Lyngby). Planet. Space Sci.; 19: No. 11, 1475-95(Nov 1971).

Three rocket payloads with vlf receivers were launched during auroral disturbances to study vlf hiss in the ionosphere. One payload was launched during relatively quiet conditions and penetrated a quiet auroral arc. Another payload was launched during the break up phase of the aurora at the start of a magnetic substorm. The third payload was launched in a situation that was similar to an after-breakup auroral-glow situation. From the 7.35-kHz hiss observations on these three payloads it is concluded that in some circumstances auroral hiss is generated in the auroral arcs at altitudes of 105 to 110 km. The observations also show that auroral hiss often is present in the ionosphere even if it is not observed on the ground. The observed variation in intensity of auroral hiss is interpreted as being caused by absorption as the hiss propagates away from a generation region at 105 to 110 km or propagates down from greater altitudes. This interpretation, together with the occasional spin modulation of the observed signals, indicates that the wave normal direction for auroral hiss often is within a few degrees of the resonance cone (89.7°). (auth)

7643 EQUATORIAL IONOSPHERIC DRIFT AND THE ELECTROJET. Chandra, H.; Misra, R. K.; Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). Planet. Space Sci.; 19: No. 11, 1497-1503(Nov 1971).

Results of horizontal drift measurements at Thumba (0.6°S dip), a station situated at the magnetic equator, are studied in relation to the equatorial electrojet currents estimated from the variations of H component of the geomagnetic field. The daily, seasonal, and latitudinal variations of drift show a close similarity between the drift and electrojet. Even the short-time variations such as day-to-day differences or temporary changes lasting only a few hours in the magnetic field have corresponding effects on the drift parameters. It is concluded that the drift measurements near the equator indicate the electron movements and are a good index of the ionospheric currents. (auth)

7644 HYDROGEN DENSITY AND PROTON FLUX IN THE TOPSIDE IONOSPHERE OVER ARECIBO, PUERTO RICO, FROM INCOHERENT SCATTER OBSERVATIONS. Ho, M. C. (Univ. of Western Ontario, London); Moorcroft, D. R. Planet. Space Sci.; 19: No. 11, 1441-55(Nov 1971).

Incoherent-scatter observations of the topside ionosphere over Arecibo, Puerto Rico, were analyzed and interpreted to give values for the neutral hydrogen density and vertical proton flux throughout a 30-hr period on December 7 and 8, 1965. The neutral hydrogen density is of the order of 10^6 cm^{-3} at 520 km, agreeing well with other recent measurements. A diurnal variation of about 2 to 1 was found, which confirms recent theoretical predictions. The vertical proton flux attained a maximum value of about 10^9 cm^{-2} sec^{-1}, being upward in the daytime and downward at night. The daytime flux appears to be of comparable magnitude with the limiting flux permitted, but the shape of the ion-density profile suggests that the flux was not actually a limiting flux. For the night in question, the downward proton flux appears to account for the maintenance of the F layer, perhaps with some additional contribution from neutral winds and/or electric fields. (auth)

7645 ENTRY OF SOLAR PROTONS OVER THE POLAR CAPS. Morfill, G. E.; Quenby, J. J. (Imperial Coll. of Science and Tech., London). Planet. Space Sci.; 19: No. 11, 1541-77 (Nov 1971).

Observations of solar protons at energies from 1 to 360 MeV are examined in relation to the information that these particles give about the magnetosphere, magnetotail, and magnetopause. Trajectory integrations in a realistic model of the geomagnetic field out to $25R_E$ and a tail field model fitted to observations from 15 to $80R_E$ are used to obtain a better understanding of the particle motion. The mean free path of protons in the tail is found to be $700R_E$ and $200R_E$ for 100MeV and 1 MeV protons respectively, which indicates that trajectory calculations in a static field model are valid. Structure over the polar caps at low altitudes due to interplanetary anisotropies was observed for protons >30 MeV during the solar flares of November 18th 1968 and February 25th 1969. Apart from an easily explained direct impact-zone structure, fluxes corresponding to peak anisotropic interplanetary intensity were observed to come from deep in the magnetotail. A magnetopause model of the generalized rotational discontinuity type, with a diverging tail field, is proposed and it is shown that this allows particle access into the tail with conservation of the distribution function. Observations show that 1-MeV protons become isotropic at the magnetopause.

Particle trajectories crossing the neutral sheet are analyzed, and it is shown that dispersion of trajectories produces broadening of sharp interplanetary intensity changes when observed in the tail, not by a diffusion process, but through different trajectory lengths. Results of trajectory integrations at three energies are presented. Results of nonadiabatic particle motion in the pseudo-trapping region are shown. (auth)

7646 NEW MECHANISM OF AURORAL ARCS. Ogawa, Tadahiko; Sato, Tetsuya (Kyoto Univ.). Planet. Space Sci.; 19: No. 11, 1393-1412(Nov 1971).

A new mechanism of quiet auroral arcs is presented in which the leading part of arc formation is played by the ionosphere. The theory basically consists of two stages: firstly, it is shown that the ionosphere is subject to the macroscopic cross-field instability resulting in a wavy irregularity of ionization whose spatial characteristics are coincident with those of auroral arcs. Secondly, a model is presented showing that such an irregularity (to-be arc) develops into auroral arcs under the influence of field-aligned current triggered by an induced potential across a to-be arc. The model is numerically examined for a number of parameter sets to find that the ionospheric irregularity can certainly result in auroral arcs. The calculated results are compared with recent experiments of auroral arcs. Deformation of an arc is also discussed in terms of the cross-field instability. (auth)

7647 THEORETICAL N_2 VIBRATIONAL DISTRIBUTION IN AN AURORA. Schunk, Robert W.; Hays, Paul B. (Univ. of Michigan, Ann Arbor). Planet. Space Sci.; 19: No. 11, 1457-61 (Nov 1971).

The N_2 vibrational distribution in an aurora is investigated. During the auroral bombardment the vibrational distribution is non-Boltzmann. The deviation from the Boltzmann distribution increases with increasing altitude. Above 200 km the loss rate of O^+ due to the reaction $O^+ + N_2 \rightarrow NO^+ + N$ is increased by a factor of 1.5 when allowance is made for the non-Boltzmann character of the N_2 distribution. This increased loss rate persists for 1000 to 2000 sec after auroral bombardment commences. (auth)

7648 STUDY OF THE AURORAL ABSORPTION SUBSTORM. Berkey, Frank Thomas. College, Alaska; Univ. of Alaska (1971). 338p. University Microfilms Order No. 71-30,073.

Thesis.

An attempt was made to understand the temporal and spatial variations of auroral radio-wave absorption. The results of an experiment that correlated the variations of auroral-light intensity with those in auroral absorption are described. These measurements were carried out over a small angular cone, which intercepted an area of less than 400 km^2 at auroral heights. The spatial coherence of auroral absorption and auroral luminosity was examined, as was the correlation of absorption with auroral emission at several wavelengths. It was concluded that the spatial region in which radio-wave absorption occurs is of larger dimensions than the visual emitting region. From a large statistical sample, it was demonstrated that absorption correlates best with 4278A auroral luminosity and that the correlation is better during substorm occurrences. The temporal correlation of absorption and luminosity during substorms was illustrated by several examples. A synoptic study of the geographical distribution of auroral absorption during 5 IQSY substorms was undertaken. A cooperative study provided radio-wave-absorption data from more than 20 observatories in the northern hemisphere for this purpose. It was shown that absorption spreads longitudinally from a source located in the midnight sector. The westward expansion of absorption along the auroral oval was documented for the first time. The eastward drift was studied in detail; a differential drift rate with latitude was found, which was also asymmetric with respect to the dawn meridian. The observed drift rate of precipitation was found to be in agreement with the theoretical calculation of the gradient and curvature drift velocities of energetic electrons in the trapping region. A model of the auroral absorption substorm is proposed. (Diss. Abstr. Int., B)

7649 BEHAVIOR OF MIDLATITUDE IONOSPHERE DURING GEOMAGNETIC STORMS. Mendillo, Michael Joseph. Boston; Boston Univ. (1971). 208p. University Microfilms Order No. 71-26,455.

Thesis.

The drastic changes in electron density (Ne) that occur during periods when the Earth's magnetic field is disturbed represent one of the major problems in ionospheric physics. Much effort has been put into this problem of "ionospheric storms," but complete morphological descriptions and adequate explanations have been slow in coming. With the advent of geostationary satellites, it became possible to measure on a continuous basis an ionospheric parameter well suited for an analysis of storm effects. By monitoring the amount of Faraday rotation a vhf radio signal experiences in traveling through the ionosphere, one can determine the integral with height of the Ne(h) profile. This quantity is called the ionospheric Total Electron Content (TEC). Here, over two years worth of Faraday rotation records are used to obtain the first complete description of the TEC behavior during geomagnetic storms. The measurements were made at the AFCRL's Sagamore Hill Radio Observatory in Hamilton, Massachusetts, and pertain to a sub-ionospheric point at 39°N and 70°W. (TSS) (Diss. Abstr. Int., B)

7650 MOTION OF ENERGETIC CHARGED PARTICLES IN THE MAGNETOSPHERE. Roederer, Juan G. (Univ. of Denver). pp 131-47 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. I. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.1).

A review is given of current knowledge of energetic-particle motion in the magnetosphere, the applicability to cosmic-ray investigations being that radiation-belt studies were predicted and discovered by cosmic-ray scientists. Many physical processes in radiation-belt dynamics that are relevant to cosmic-ray dynamics may be found. 13 references. (IAA)

Low-Temperature Physics and Cryogenic Equipment

Refer also to abstract 7826.

Superfluidity

7651 CRITICAL VELOCITIES AND GENERATION OF VORTICITY IN LIQUID HELIUM II IN LARGE PIPES OF RECTANGULAR CROSS SECTION AT 1.40K. Slater, William James. Vancouver, B. C.; Univ. of British Columbia (1971). National Library of Canada, Ottawa.

Thesis.

Critical velocities were measured in liquid helium at 1.40 K for counterflow, superflow, and counterflow superimposed on superflow. The measurements were made in five pipes having rectangular cross sections and ranging in size nominally from 0.2 × 1.2 × 10 cm to 1.2 × 1.2 × 10 cm. The turbulence was detected by means of negative-ion currents perpendicular to the flow. The results are interpreted in terms of creation of quantized vortex lines. For superflow, the critical velocities were slightly higher but within the experimental range of those measured for counterflow. For the case of superflow-plus-counterflow a second critical point was observed in addition to the one corresponding to superflow only. Considerable data were also collected regarding the nature of the ionic current attenuation effects for supercritical flow. The delay times between when the flow rate was raised to or above the critical velocity and, when the current attenuations were first observed, ranged from more than five minutes for the smallest pipe to three-quarters of a minute or less for the largest one. When the pipe width is greater than the ion source width the attenuations may be explained by Vinen's theory of vortex generation and decay, but for smaller pipe widths the attenuation buildup and decay times are greatly increased. A method for increasing the sensitivity of the detection method for large pipes is also outlined. (Diss. Abstr. Int., B)

7652 THERMAL EMISSION OF ELECTRONS FROM LIQUID HELIUM. Schoepe, W.; Rayfield, G. W. (Technische Univ., Munich). Z. Naturforsch.; 26a: No. 9, 1392-7(Sep 1971).

The free surface of liquid helium acts as an energy barrier for electrons crossing the surface from the liquid into the vapor. The barrier is shown to be induced by the dielectric image-potential acting on the electrons below the liquid vapor interface. The application of an extracting electric field across the surface reduces the barrier and leads to a potential well below the surface that traps the electrons for extended periods of time. The escape into the vapor phase is shown to be dominated by thermal diffusion from the potential well according to Smoluchowski's equation. By measuring the escape rate, a barrier height of 43.8 ± 0.7 K was found. The top of the well lies 25 Å below the liquid vapor interface. Close to the λ point and at higher temperatures the escape rate deviates from the theory. The relevancy of the present work for previous and further investigations of thermal electron emission from liquid helium is discussed. (auth)

7653 PERSISTENT-CURRENT MEASUREMENTS OF THE SUPERFLUID DENSITY AND CRITICAL VELOCITY. Clow, James R.; Reppy, John D. (Yale Univ., New Haven). Phys. Rev., A; 5: No. 1, 424-38(Jan 1972).

Gyroscopic measurements of superfluid persistent currents in liquid helium below and near the λ transition are presented here. Measurements were conducted in a variety of sizes of porous material from 0.05- to 150-μ average size. Near the λ transition, both the superfluid density ρ_s/ρ and the critical velocity ω_c exhibit a ⅔-power dependence on the temperature difference from the transition. A depression of the λ transition is observed for both ρ_s/ρ and ω_c in the smallest pores. Data for ρ_s/ρ and ω_c away from the transition and down to about 1.25°K are given and are in agreement with measurements made by other methods. (auth)

7654 BOUND ROTON PAIRS IN SUPERFLUID HELIUM. Zawadowski, A. (Univ. of Virginia, Charlottesville. Central Research Inst. for Physics, Budapest); Ruvalds, J.; Solana, J. Phys. Rev., A; 5: No. 1, 399-421(Jan 1972).

It has recently been proposed that several anomalous features in Raman and neutron scattering experiments on superfluid helium can be explained by the formation of two-roton bound states. Here, the structure in the superfluid helium excitation spectrum associated with bound roton pairs is analyzed in detail, and further experiments are proposed to examine the nature of the bound states. The two-roton spectrum is calculated including roton–roton interactions over a wide momentum range, and exhibits structure due to bound states which is in remarkable agreement with experiment. Interaction of the two-roton bound state with the single-particle excitations results in a hybridization of these states and a consequent splitting of the single-particle spectrum into two branches; the calculated momentum dependence of these branches is consistent with the neutron data. Inclusion of a finite roton lifetime is shown to be essential to the interpretation of the experimentally observed excitation spectrum in the vicinity of the bound-state energy. Possible physical mechanisms for the roton–roton interaction are considered, and the angular momentum character of the bound states is briefly discussed. (auth)

7655 REMNANT BOSE CONDENSATION IN ^{4}He SUBMONOLAYER FILMS. Widom, A.; Sokoloff, J. B. (Northeastern Univ., Boston). Phys. Rev., A; 5: No. 1, 475-6(Jan 1972).

The recent specific-heat data of Bretz and Dash have been interpreted as evidence of two-dimensional inhomogeneous remnant Bose condensation in ^{4}He submonolayer films. For specific heats and for adsorption isotherms quantitative relationships are suggested that verify this point of view. (auth)

7656 MOTION OF IONS IN HELIUM II. Padmore, Timothy C. (Georgia Inst. of Tech., Atlanta). Phys. Rev., A; 5: No. 1, 356-72(Jan 1972).

The general motion of ions in He II is investigated, assuming that nucleation of and escape from vortex rings is a random thermally activated process. The mean drift velocity v_d is calculated as a function of temperature, applied field, and ionic species. It is shown that low-field data up to and just beyond the giant discontinuity can be explained, provided careful attention is paid to the friction forces on small rings, by assuming that v_d is the equilibrium drift velocity. The transition between bare-ion and vortex-ring behavior is discussed in some detail. At higher fields one must take into account vortex-ring dynamics and the possibility of escapes. In general v_d is larger than the equilibrium velocity and, for very large fields, increases with field. Predictions of the theory are compared with experimental drift-velocity data. Also considered are the characteristics of ion currents in nonuniform fields. In particular, predictions are made for the persistence current observed when ions propagate first through a region of constant field, then through a region of zero or retarding field. (auth)

7657 CRITICISM OF THE SINGLE-PARTICLE-GREEN'S-FUNCTION APPROACH TO THE EXCITATION SPECTRUM OF SUPERFLUID LIQUID HELIUM. Straley, J. P. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., A; 5: No. 1, 338-41(Jan 1972).

The experimentally observed spectrum for superfluid liquid helium has properties that are characteristic of a sound spectrum but in disagreement with the predictions of a naive use of the single-particle-Green's-function approach. It is argued that the dynamical origins of the spectrum are closely related to those that give rise to sound propagation in normal liquids and, therefore, that the helium spectrum should be sought in structures and formalisms that would be used to study sound in normal liquids. (auth)

7658 X-RAY SCATTERING FROM LIQUID ^{4}He. Hallock, Robert B. (Stanford Univ., Calif. Univ. of Massachusetts, Amherst). Phys. Rev., A; 5: No. 1, 320-30(Jan 1972).

The liquid structure factor of ^{4}He was measured in the momentum transfer range from 0.133 to 1.125 Å^{-1} and a variety of temperatures from 0.38 to 4.6 K. At the lowest temperature, the structure factor demonstrates a gentle change of slope in the momentum transfer region near 0.4 Å^{-1}. Values for the first and second moments of the pair correlation function are obtained at 1.45 and 3.30 K. The results are compared with recent neutron and x-ray work and also with recent theories. (auth)

7659 ULTRAVIOLET EMISSION SPECTRUM OF ELECTRON-BOMBARDED SUPERFLUID HELIUM. Stockton, M.; Keto, J. W.; Fitzsimmons, W. A. (Univ. of Wisconsin, Madison). Phys. Rev., A; 5: No. 1, 372-80(Jan 1972).

The emission spectrum of electron-bombarded superfluid helium was measured as a function of wavelength between 600 and 1100 Å. The spectrum is characterized by a very intense band of continuous emission peaking at approximately 800 Å, along with a series of less intense bands between the wavelengths of 600 and 710 Å. This continuum is interpreted in terms of the radiative dissociation of neutral helium molecules in the reaction $A^1\Sigma_u^+ \rightarrow X^1\Sigma_g^+$. The over-all intensity corresponds to about 5×10^{15} (photons/sec)/μA of 160-keV electron beam excitation. The uv fluorescence of electron-bombarded superfluid helium is by far the most intense emission of the excited liquid and may represent a useful source of uv light. (auth)

7660 SUPERFLUID WAVES. Boillat, Guy; Greco, Antonio (Univ., Messina, Italy). Compt. Rend., Ser. A; 273: No. 14, 654-6(4 Oct 1971). (In French).

Calculations are made on the velocities and discontinuities associated with superfluid He II. (France)

7661 SPATIAL DISTRIBUTION OF SUPERFLUID VORTICES. Shenk, D. Scott; Mehl, James B. (Univ. of Delaware, Newark). Phys. Rev. Lett.; 27: No. 25, 1703-6(20 Dec 1971).

Accurate measurements are reported of the increase, due to rotation, of the attenuation of second sound in an annulus. The measurements can be explained in detail by a vortex-free–region model in close agreement with theory, assuming a vortex-core parameter at 10 Å at 1.65 K. The range of agreement extends from the vorticity threshold to relatively high angular velocities. (auth)

7662 MACROSCOPIC QUANTUM UNCERTAINTY PRINCIPLE AND SUPERFLUID HYDRODYNAMICS. Putterman, S. J.; Finkelstein, R.; Rudnick, I. (Univ. of California, Los Angeles). Phys. Rev. Lett.; 27: No. 25, 1697-9(20 Dec 1971).

By application of a macroscopic quantum uncertainty principle to the flow of superfluid helium, one can understand the onset of third sound in thin helium films, and the large excess absorption of third sound in thick helium films. (auth)

Superconductivity

Refer also to abstracts 7201 and 7239.

7663 ELECTRICAL RESISTANCE PEAK IN SUPERCONDUCTING LEAD FILMS IN A PERPENDICULAR MAGNETIC FIELD. Gray, K. E.; Everett, G. J.; Kampwirth, R. T.; Huebener, R. P. (Argonne National Lab., Ill.). Phys. Status Solidi (a); 7: No. 2, K73-6(16 Oct 1971).

Current–voltage measurements were made in ~3-μm-thick (Type-I) Pb films in a perpendicular magnetic field before and after the sloping edges were scraped off. Before scraping, the I–V curve shows an abrupt change of slope ("knee"); after scraping, no such knee is observed. This difference is probably due to the excess conductivity of the sloping edges. A plot of critical current at the knee vs field shows the peak effect of Type-II superconductors, indicating that the sloping edges are Type-II. In the plot of resistance vs field, the unscraped samples show a peak above the critical field. It is concluded that sloping edges are important in transport measurements in thin-film superconductors, and that they strongly influence the appearance of the resistance peak. (D.L.C.)

7664 NORMAL-STATE RESISTANCE AS THE DETERMINING PARAMETER IN THE BEHAVIOR OF DAYEM BRIDGES WITH SINUSOIDAL CURRENT-PHASE RELATIONS. Gregers-Hansen, P. E.; Levinsen, M. T. (Univ. of Copenhagen). Phys. Rev. Lett.; 27: No. 13, 847-9(27 Sep 1971).

It is shown experimentally that both the ac and dc properties of small Dayem bridges are fully determined at all temperatures by their normal-state ohmic resistances. The behavior can be described by a two-fluid model where the normal component is governed by the normal-state resistance and the superfluid component determined by the two Josephson equations. The normal-state resistance also determines the maximum supercurrent. (auth)

7665 AC LOSSES IN ROTATING AND RECIPROCATING SUPERCONDUCTORS AND NORMAL CONDUCTORS. Harrowell, R. V. (Central Electricity Research Labs., Leatherhead, Eng.). J. Phys., D (London); 4: No. 11, 1769-75(Nov 1971).

The generation of an alternating voltage by varying the velocity with which a conductor cuts a uniform magnetic field should not be accompanied by the production of ac losses. Experiments to check this theory are described for both superconductors and normal conductors. Samples of each type of conductor were rotated at 3000 rpm and then reciprocated at the same frequency, and the losses measured by noting the increase in power ΔP required by the driving motor when the uniform magnetic field was switched on. Significant values of ΔP were recorded for both the normal and superconducting samples when rotated, even in the lowest flux densities (~ 0.1 T). When reciprocated, however, it was not possible to detect ΔP for either type of sample, even in $B = 5$ T. This means that the copper losses were less than 0.1% and the Nb–Ti losses less than 0.1% of the respective rotational losses under the same electromagnetic conditions; it also implies that the superconductor losses were less than those appropriate to the superficial transport current density (5.5×10^4 A m^{-1}) that might be used in a large generator employing the reciprocating principle. (auth)

7666 EFFECT OF INHOMOGENEITIES ON THE PROPERTIES OF SUPERCONDUCTORS. Larkin, A. I.; Ovchinnikov, Yu. N. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 3, 1221-30(Sep 1971). (In Russian).

Inhomogeneities in the electron interaction constant and in the mean free path result in a smearing out of the superconducting transition and fixation of vortices in the mixed state. The relation between the smearing-out width of the phase transition and critical pinning current in thin films is found. The distribution of the current density and vortex density over the film thickness is obtained. (auth)

7667 AC SUPERCONDUCTIVE PROPERTIES AND STRUCTURE OF SPUTTERED NIOBIUM FILMS. Arton, K. A. M.; Hlawiczka, P. (Univ. of Glasgow). J. Phys., D (London); 4: No. 11, 1762-8(Nov 1971).

The penetration of magnetic flux and ac losses were measured at 50 Hz in superconducting niobium films deposited by sputtering on the inside of cylindrical substrates, and the results are compared with other work on ac losses. Flux penetration was found to be localized at pinholes and similar defects in the films. (auth)

7668 EFFECT OF FLUCTUATIONS IN SUPERCONDUCTING ALLOYS ABOVE THE TRANSITION TEMPERATURE. Patton, Bruce Riley. Ithaca, N. Y.; Cornell Univ. (1971). 148p. University Microfilms Order No. 71-29,262.

Thesis.

A calculation of the density of states and the electromagnetic response of a dirty superconductor above its transition temperature are presented. An essential aspect is the careful use of the standard-impurity averaging technique, which leads to the resolution of an anomaly in the theory of the fluctuation-induced conductivity of an impure superconductor. In addition, the theory presented is formally capable of describing the approach to the BCS state below T_c in samples of restricted dimensionality. (Diss. Abstr. Int., B)

7669 INELASTIC ELECTRON COLLISIONS AND NON-EQUILIBRIUM STATIONARY STATES IN SUPERCONDUCTORS. Eliashberg, G. M. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 3, 1254-72(Sep 1971). (In Russian).

A derivation of the dynamic equations for superconductors is presented in which inelastic collisions between electrons or between electrons and phonons are taken into account explicitly. It is assumed that the phonons are in equilibrium (play the role of a thermostat). The conditions for which this assumption is valid are discussed. The equations are written in a form which is analogous to the kinetic equation but their structure is much more complex than for a normal metal. This complication is mainly due to the necessity of taking into account changes in the excitation spectrum density induced by a varying external field. For thin films, taken as an example, it is shown that under certain conditions the varying field effect mainly consists in a redistribution of the excitations with respect to energy, the spectrum density remaining constant. In this case, the equation set reduces to an equation for the energy gap which is identical with respect to form to the BCS equation but with a nonequilibrium distribution function, and to a nonlinear kinetic equation for this function. (auth)

7670 SUPERCONDUCTING COMPOUNDS OF METALS AND THEIR APPLICATION. Savitskii, E. M.; Efimov, Yu. V. pp 408-14 of Metallovedenie. Struktura i Svoistva Stalei i Splavov Metallidy Novye Metody Issledovaniya. /Ageev, N. V. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Symposium on metallurgy and metallography; Moscow, USSR (14 May 1968).

A comparative study of the superconductivity of various binary and ternary metallic compounds was made in relation to their crystalline structure, average concentration of valence electrons, location of components in the periodic system, and the metallurgical history involved in the sample preparation. The crystalline structure and the shape of the Fermi surface of metallic compounds exhibiting superconductivity were investigated. The effects of alloying, admixtures, pressure, and other factors on the superconducting properties of metallic compounds were examined. Some correlations were made with the binary phase diagrams of systems such as V–Si, Nb–Sn, Nb–Ga, Mo–Re, and W–Re. (K.S.W.)

7671 FLUCTUATIONS NEAR THE PHASE TRANSITION IN ONE-DIMENSIONAL SUPERCONDUCTORS. Warburton, Richard Julius. Ithaca, N. Y.; Cornell Univ. (1971). 140p. University Microfilms Order No. 71-29,271.

Thesis.

The effects of fluctuations on the superconducting-resistive phase transition in one-dimensional tin and tin–indium alloy whisker crystals near to T_c were studied. These are single crystals with uniform cross sectional areas of 10^{-9} to 10^{-8} $(cm)^2$ and lengths of 10^{-2} to 10^{-1} cm. Measurements were made using both a conventional nanovoltmeter and a superconducting voltmeter that utilizes a quantum interference flux detector for the measurement of voltage, resistance, and inductance. It was verified that the voltage appearing near the onset of the transition for $T \lesssim T_c$ in one-dimensional specimens is determined by the rate of thermally activated quantum phase slips of magnitude 2π as proposed by Langer and Ambegaokar. The strongest experimental evidence is the direct observation of the thermally activated phase slips and the confirmation of the basic current–voltage relationship at constant temperature, $V \propto \sinh\{I/2I_1\}$, for currents small compared to the critical current, $I \ll I_c(T)$, where the parameter $I_1 \simeq 2.5 \times 10^{-8}$ amps. The onset of the resistive transition in the zero current limit is in excellent agreement with the predictions of Langer and Ambegaokar if an experimentally determined attempt frequency, N(exp), which is reduced by a factor of 10^0 to 10^2 from the attempt frequency predicted by McCumber and Halperin is used. The dependence of the critical current (at constant resistance) on temperature for currents $I \lesssim I_c(T)$ is in excellent agreement with the theory of Langer and Ambegaokar with the attempt frequency of McCumber and Halperin. Although attention was concentrated on the region $T \lesssim T_c$, the total resistive transition near T_c was measured and compared to several fluctuation theories for $T \gtrsim T_c$. The results strongly suggest that in the dirty limit, where the mean free path is much less than the coherence length, $l \ll \xi_0$, a smooth extrapolation between the theories of Langer and Ambegaokar with the attempt frequency of McCumber and Halperin for $T \lesssim T_c$ and Tucker and Halperin for $T \gtrsim T_c$ will provide a quantitative description of the total transition region near to T_c. (TSS) (Diss. Abstr. Int., B)

7672 CLEAN SUPERCONDUCTING FILMS COATED WITH NORMAL METAL AT LOW TEMPERATURES. Cleary, Robert M. (Univ. of Illinois, Urbana). Phys. Rev., B; 5: No. 1, 67-73(1 Jan 1972).

A theoretical study of clean superconducting films embedded in normal metal is presented. With an approximate pair potential, the tunneling and average density of states at the Fermi surface and the low-temperature thermal conductivity of a film are computed as a function of film thickness d. The density of states and thermal conductivity are a universal function of $d/\xi(T)$ in this approximation, where $\xi(T) = v_F/\pi\Delta(T)$ accounts for all the temperature dependence in the problem. (auth)

7673 SUPERCONDUCTING BEHAVIOR OF THIN FILMS AND SMALL PARTICLES OF ALUMINUM. Townsend, P.; Gregory, S.; Taylor, R. G. (Univ. of Essex, Colchester, Eng.). Phys. Rev., B; 5: No. 1, 54-66(1 Jan 1972).

Tunneling measurements were made of the transition temperatures of films of aluminum in the thickness range 400 to 20 Å. The highest T_c observed was 5.7°K, in agreement with other measurements. Softening of the average phonon frequency by low-frequency surface phonons does not provide sufficient enhancement to explain the observed results. It is therefore concluded that disorder within the metal itself is the operative mechanism for enhancement. Films of ~20Å thickness show no evidence of an energy gap, but they do show a magnetic effect which is interpreted in terms of paramagnetic impurity associated with the highly disordered metal/oxide interface. It is suggested that it is these paramagnetic ions that act as pair breakers and suppress the transition temperature in ultrathin films. (auth)

7674 MASS AND VOLUME DEPENDENCES OF THE ELECTRON–ELECTRON INTERACTION IN SUPERCONDUCTORS. Nakajima, Tetsuo (Tohoku Univ., Sendai). J. Phys. Soc. Jap.; 31: No. 6, 1608-11(Dec 1971).

A way of discussing the mass and volume dependences of the electron–electron interaction is proposed for superconductors, based upon the empirical relations between the isotope effect and including the volume change in isotopes and the volume effect of the superconducting transition temperature. (auth)

7675 NMR STUDIES ON MAGNETIC IMPURITY EFFECT IN TYPE-II SUPERCONDUCTORS. Masuda, Yoshika; Hashimoto, Masahiro (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 31: No. 6, 1661-70(Dec 1971).

The nuclear spin–lattice relaxation time T_1 of ^{27}Al in a type II superconductor $La_{3-x}Gd_xAl$ was measured as a function of concentration of Gd impurity, x, as well as temperature and magnetic field. The experimental results can be understood well on the basis of the current theory of magnetic-field-induced gapless superconductivity in the dirty limit, as in the case of V_3Sn previously published. Relaxation rates in superconducting states in the case of x = 0.2 at. % are decreasing functions of the external magnetic field. This anomalous relaxation behavior is contrary to the case of spin diffusion, in which case T_1 is a decreasing function of the external magnetic field. These facts suggest that this relaxation mechanism is due to the indirect coupling between nucleus and magnetic impurities. The experimental result for x = 0.5 at. % is also discussed. (auth)

7676 LOCAL VARIATION OF AN ORDER PARAMETER AND AN ISOLATED STATE INSIDE THE ENERGY GAP IN A SUPERCONDUCTOR WITH A MAGNETIC IMPURITY. Kuroda, Yoshihiro (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 3, 688-700(Sep 1971).

Effect of the local variation of the order parameter on an isolated state inside the energy gap in a superconductor with a magnetic impurity is studied by a simplified model. It is verified that in a weak limit of the impurity potential such an effect leads to an unimportant modification of the energy of the isolated state but induces new innumerable isolated states. (auth)

7677 INFLUENCE OF REACTOR IRRADIATION AT HELIUM TEMPERATURE ON THE PINNING OF ABRIKOSOV FLUXOIDS IN SINGLE-CRYSTAL NIOBIUM. Andronikashvili, E. L.; Ashimov, S. M.; Tsakadze, Dzh. S. (Inst. of Physics, Tbilisi, USSR). JETP Lett. (USSR) (Engl. Transl.); 14: No. 5, 197-9(5 Sep 1971).

$_{25}$Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 5, 299-301(5Sep 1971).

Using the currentless procedure previously developed, the effect of neutron irradiation on the pinning force in single-crystal niobium was investigated. Results of measurement of the critical angle before and after irradiation are given. (M.H.R.)

7678 SUPERCONDUCTIVITY AND STRUCTURE OF COMPOUNDS BASED ON NIOBIUM AND VANADIUM. Kodess, B. N.; Shekhtman, V. Sh. (Inst. of Solid State Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 14: No. 5, 225-8 (5 Sep 1971).

$_{25}$Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 5, 338-41(5 Sep 1971).

A number of alloys containing compounds with A15 structure in the ternary systems Nb–Ge–Al and V–Ge–Al were studied. Data obtained on the concentration dependence of T_c in the alloys are shown. Neutron-diffraction patterns were obtained for a sample with composition V_3 $(Ge_{0.75}Al_{0.25})$ in the cost state and after annealing at 850° for 375 hours. The line intensity was compared with calculation. (M.H.R.)

7679 CRITICAL TEMPERATURE OF AMORPHOUS SUPERCONDUCTING FILMS. Kulik, I. O. (Physical-Technical Inst. of Low Temperatures, Kiev). JETP Lett. (USSR) (Engl. Transl.); 14: No. 5, 228-30(5 Sep 1971).

$_{25}$Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 5, 341-4(5 Sep 1971).

Previously, Naugle and Glover (Phys. Lett., 28A: 611(1969)) observed a decrease of the critical temperature of the superconducting transitions of amorphous (i.e., having very high resistance) films of Bi and Ga, condensed on a low-temperature substrate, in inverse proportion to their thickness. This means that ΔT_c is proportional to the value of the normal resistance. Here an explanation for this effect is proposed, based on the assumption that the lowering of T_c is due to fluctuations of the electromagnetic field in the film. (M.H.R.)

7680 JOSEPHSON CURRENT FLOW IN PURE SUPERCONDUCTING/NORMAL/SUPERCONDUCTING JUNCTIONS. Bardeen, John; Johnson, Jared L. (Univ. of Illinois, Urbana). Phys. Rev., B; 5: No. 1, 72-8(1 Jan 1972)

It is shown that the Josephson current in a pure superconducting/normal/superconducting (SNS) sandwich with normal layer thickness large compared with the coherence distance can be calculated easily from the quasi-particle spectrum by use of Galilean invariance. The results agree with Ishii at T = 0°K and with an expression of Kulik for the bound-state contribution, but a larger contribution from states with E near Δ_0 as suggested by Kulik was not found. The expected current decreases very rapidly with increase in temperature so that it would be necessary to go to very low temperatures to observe the effect. (auth)

7681 NATURE OF THE PEAK EFFECT IN SUPERCONDUCTING TITANIUM–22 AT. PERCENT NIOBIUM ALLOY. Karasik, V. R.; Vereshchagin, V. G.; Nikitina, G. T. Kratk. Soobshch. Fiz.; No. 5, 74-80(1970). (In Russian).

The peak effect in Ti–22 at. % Nb alloy was studied. Experimental confirmation was obtained that this is connected with a breakdown of the superconductivity of ω particles (equilibrium composition of the ω phase = 12 to 13% Nb in Ti) that occurs with certain values of the external magnetic field. The actual value of the field depends on the chemical composition and dimensions of the ω particles. The results confirm earlier views on this. (Metals Abstr.)

7682 TRANSITION TEMPERATURE OF STRONG-COUPLED SUPERCONDUCTORS. Hertel, P. (Univ. des Saarlandes, Saarbruecken, Ger.). Z. Phys.; 248: No. 3, 272-84(1971). (In German).

The general structure of the equation for the critical temperature of superconductors, introduced in an earlier work, is investigated. An expression for the Coulomb pseudopotential allowing a better calculation is found without any cutoff procedure. Using an Einstein-type phonon spectrum, an explicit formula for T_c, which in case of strong-coupling superconductors differs from McMillan's expression, is given. The agreement with experimental values is good. (auth)

7683 THERMAL PHASE FLUCTUATIONS IN A JOSEPHSON JUNCTION AND PAIR SUSCEPTIBILITY OF A SUPERCONDUCTOR. Anderson, John Thomas. Minneapolis; Univ. of Minnesota (1971). 183p. University Microfilms Order No. 71-28,207. Thesis.

Two experiments were carried out: one an investigation of the behavior of a Josephson junction when the internal coupling energy is on the order of the thermal energy, the other an investigation of fluctuation-induced conductivity in bimetallic Josephson junctions at temperatures between the transition temperatures of the two metal films composing the junction. The coupling energy of a Josephson junction is reduced to the order of thermal energies in the vicinity of either the transition temperature or the minima of the zero-voltage current versus applied magnetic field curve. The effects of thermal fluctuations can be observed as a rounding of the current–voltage characteristic. $Sn/Sn_xO_y/Sn$ crossed-film Josephson junctions were used to study this effect. The data is in qualitative agreement with the theory of Ambegaokar and Halperin. Thermal fluctuations above the transition temperature of a superconductor give rise to electron pairs with a finite lifetime. In a Josephson junction consisting of two metals with different transition temperatures, fluctuation-induced electron pairs result in an enhanced conductivity of the junction at temperatures between the transition temperatures of the individual metals. The enhanced conductivity is manifested by a current in excess of the quasi-particle current that flows in the junction. A phenomenological calculation of the excess current is presented. The excess current was experimentally investigated using $Sn/Sn_xO_y/Pb$ Josephson junctions masked to eliminate effects resulting from graded film edges. Details of the variation of the excess current with voltage, magnetic field, and temperature are in agreement with a calculation by Scalapino in which the excess current–voltage characteristic is a direct measure of the imaginary part of the frequency and wave number dependent pair susceptibility of a superconductor above T_c. Estimates of the pair relaxation frequency in tin based on the data are 50% greater than theoretical predictions. (Diss. Abstr. In., B)

7684 SELECTION RULES FOR TUNNELING INTO SINGLE-CRYSTAL SUPERCONDUCTORS. Gregory, W. D.; Averill, R. F.; Straus, L. S. (Georgetown Univ., Washington, D. C.). Contract AT(40-1)-3665. Phys. Rev. Lett.; 27: No. 22, 1503-6(29 Nov 1971).

The first conclusive evidence for a tunneling selection rule for single-crystal superconductors is presented. Using tunneling data for the (001) plane of gallium obtained in two different laboratories, it is shown that the zero transverse k-vector rule of Dowman, Mac-Vicar, and Waldram is superior to the usual group-velocity rule. The dominant tunnel direction in real space is the normal to the tunnel barrier and does not appear to be affected by barrier orientation or structure. (auth)

7685 FLUCTUATION HEAT CAPACITY IN SUPERCONDUCTING THIN FILMS OF AMORPHOUS BiSb. Zally, G. D.; Mochel, J. M. (Univ. of Illinois, Urbana). Phys. Rev. Lett.; 27: No. 25, 1710-12(20 Dec 1971).

With a resolution of 10^{-10} J/°K the fluctuation heat capacity was observed near T_c in thin films of $Bi_{0.4}Sb_{0.6}$. No indication of peaking was seen in the heat capacity near T_c. The heat-capacity transition when compared with the corrected resistivity transition is found to have approximately twice the width. This width is 3 times that predicted by Ferrell. (auth)

7686 JOSEPHSON EFFECTS IN A BULK GRANULAR SUPERCONDUCTOR. Warman, J.; Jahn, M. T.; Kao, Y. H. (State Univ. of New York, Stony Brook). J. Appl. Phys.; 42: No. 12, 5194-6(Nov 1971).

Experimental results are presented for the dc and ac Josephson effects found in a bulk granular superconductor comprised of about 10^4 superconducting grains (less than 45 μ in dimension) packed in an insulator capsule. This new type of Josephson weakly coupled superconductor offers high sensitivity in response to microwave radiations with a noise-equivalent power as low as 10^{-14} $\text{W/(Hz)}^{1/2}$. (auth)

7687 ENHANCEMENT OF SUPERCONDUCTING TRANSITION TEMPERATURES OF Ti–Mo (5, 7 AT. PERCENT) ALLOYS BY MECHANICAL DEFORMATION. Ho, J. C.; Collings, E. W. (Battelle Memorial Inst., Columbus, Ohio). J. Appl. Phys.; 42: No. 12, 5144-50(Nov 1971).

Low-temperature calorimetric measurements have shown that severe mechanical deformation of Ti–Mo (5 and 7 at. %) alloys, although it has little influence on either the density of states or the Debye temperature, significantly enhances the superconducting transition temperature. The net effect of the deformation is thus to distort the phonon spectrum in such a way as to favor the superconducting electron coupling. (auth)

Equipment and Devices

7688 SIMPLE POINT-CONTACT JOSEPHSON JUNCTION FOR USE IN THE MILLIMETRE AND SUBMILLIMETRE WAVELENGTH REGIONS. Blaney, T. G. (National Physical Lab., Teddington, Eng.). J. Phys., E (London); 4: No. 12, 945-8 (Dec 1971).

A very simple arrangement for producing point-contact Josephson junctions is described. The devices are adjusted before cooling to liquid helium temperatures, and are small enough to operate in a helium storage dewar with an 18-mm-dia neck. They cannot, however, be thermally cycled without some change in electrical characteristics. Mechanical stability is much superior to the fully adjustable types of point contacts normally used for radiation studies. Some preliminary results on response to frequencies up to 1 THz are reported. (auth)

7689 SIMPLE TECHNIQUE FOR DISPLAYING THE MAGNETIC FIELD DEPENDENCE OF THE dc JOSEPHSON EFFECT. Archer, J. W.; Macfarlane, J. C. (CSIRO, Sydney). J. Phys., E (London); 4: No. 12, 1074-5(Dec 1971).

A technique is described for displaying continuously the Josephson critical current as a function of magnetic field. The display is suitable for demonstration purposes. (auth)

7690 VIBRATING SAMPLE MAGNETOMETER FOR USE WITH A SUPERCONDUCTING MAGNET. Springford, M.; Stockton, J. R.; Wampler, W. R. (Univ. of Sussex, Brighton, Eng.). J. Phys., E (London); 4: No. 12, 1036-40(Dec 1971).

The simply constructed vibrating sample magnetometer described may conveniently be used with the sample in the bore of a superconducting solenoid. The magnetometer measures the total magnetic moment of a sample vibrating parallel to a uniform applied magnetizing field, and a sensitivity (defined as the smallest detectable change of magnetic moment) of 0.5 nA m^2 (0.5 μemu) has been achieved. Automatic balancing of the magnetometer is used so that measurements are insensitive to possible circuit nonlinearities and drift and to changes in the vibration amplitude, frequency, and circuit gain. (auth)

7691 CRYOGENIC LIQUID ^{4}He BATH WITH A TEMPERATURE GRADIENT AND COEXISTING SUPERFLUID AND NORMAL PHASES. Roubeau, Pierre (CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. B; 273: No. 14, 581-3(4 Oct 1971). (In French).

A device which produces a superfluid region with a high electrical conductivity in a He bath is described. The temperature gradient appears in a surface layer of normal He in equilibrium with its saturation vapor. (auth)

7692 FACILE CRYOSTAT FOR NEUTRON DIFFRACTION EXPERIMENTS. Hirakawa, Kinshiro; Ikeda, Hironobu (Tokyo Univ.). Jap. J. Appl. Phys.; 11: No. 1, 82-4(Jan 1972).

A facile conduction-type cryostat for neutron-diffraction experiments was designed. This portable cryostat is much easier to operate than the conventional type. Liquid helium of about 2 liters can stay for fifty hours or more, and this cryostat is used at any temperature between the room temperature and 4.2 K. (auth)

7693 SUPERCONDUCTIVE MAGNET CONSTRUCTION. (to RCA Corp.). British Patent 1,254,773. 24 Nov 1971. Priority date 6 May 1968, United States.

The superconductive magnet described has a plurality of helically wound layers of superconductive ribbon comprising a superconductor coated by a normal metal to contribute stability to the magnet. The several layers of ribbon are coaxially arranged and are subjected in the operation of the magnet to different magnetic field intensities. The ribbon of a layer subjected to a lesser magnetic field has a lesser cross-sectional area of normal conductor than the ribbon of a layer that is subjected to a greater magnetic field. The cross-sectional area of the normal metal in each layer is such as to cause the several layers to contribute substantially the same degree of stability to the magnet. (M.H.R.)

Radiation Physics and Shielding

Refer also to abstracts 8554 and 8593.

Radiation Physics

Refer also to abstract 8120.

7694 MACROSCOPIC QUANTUM THEORY OF TRANSITION RADIATION: APPLICATION TO OBLIQUE INCIDENCE AND SMALL PRECIPITATES. Natta, M. (CEN, Grenoble, France). J. Phys. (Paris); 32: No. 8, 639-49(Aug 1971).

A macroscopic quantum theory for relativistic particles is developed. The result of Garibian for normal incidence ($\varphi = 0$) is extended to oblique incidence (φ not equal to 0); the energy of the transition radiation per interface is $\Delta E = (e^2/3c)\Omega p \gamma \cos \varphi$. The case of small spherical precipitates is discussed, the particle size being important in determining the exact nature of the transition radiation. For large radii a, ($a\Omega pa/c \gg 1$) the energy loss by the particle in the form of radiation is proportional to γ, the value being the mean result obtained for a plane surface. For small-radii metallic spheres ($a\,\omega_p/c \ll 1$) surface plasmons, dependent upon log γ, are excited. The possibility of using the optical region ($\omega \sim \omega_p$) of the transition radiation is discussed; it was not found to be a very promising method of identifying single particles. (France)

7695 SCATTERING OF LASER LIGHT BY 50-keV ELECTRONS. Ward, Gray Douglas. College Park, Md.; Univ. of Maryland (1971). 146p. University Microfilms Order No. 71-25,262.

Thesis.

The differential cross section for scattering of electromagnetic waves incident at 90° and polarized with E perpendicular to a 50-keV electron beam was measured at angles of 25, 35, and 50° with respect to the electron beam. The results agree with the first-order quantum electrodynamic calculation. The usual classical calculation of relativistic Thomson scattering uses a simple Lorentz transformation from the electron frame to the lab frame, and predicts a cross section more than three standard deviations from the measured result. A classical calculation that includes the finite size of the scattering region is in agreement with the quantum-electrodynamic calculation and with the measured results. (Diss. Abstr. Int., B)

7696 CALCULATION OF THE TOTAL CROSS SECTION FOR DOUBLE COMPTON SCATTERING. Wang, Pi-yin. Buffalo; State Univ. of New York (1971). 72p. University Microfilms Order No. 71-22,610.

Thesis.

The total cross section was calculated for double Compton scattering ($\gamma + e \rightarrow \gamma + \gamma + e$), and it was found that: (i) At small incident photon energies the cross section is enhanced somewhat by the possible emission of a low-energy photon. This type of enhancement becomes less important with increasing energy. (ii) At very high incident-photon energies the total cross section for double Compton scattering becomes larger than that for the usual Compton effect ($\gamma + e \rightarrow \gamma + e$) even though the latter is a lower-order process. (Diss. Abstr. Int., B)

7697 TECHNIQUES FOR MAPPING THE SPATIAL DISTRIBUTION OF STOPPING π^- MESONS IN TISSUE. Sperinde, J.; Temple, L. E.; Perez-Mendez, V.; Miller, A. J.; Rindi, A. (Univ. of California, Berkeley). Nucl. Instrum. Methods; 97: No. 2, 331-5(1971).

A number of processes leading to the emission of photons and neutrons in π^- capture reactions are discussed for potential use in radiation therapy to determine the stopping π^- region. It is concluded that the scheme of detecting collimated medium-energy γ rays is the most effective. (auth)

7698 ENERGY STRAGGLING OF FISSION FRAGMENTS IN THICK ABSORBERS. Sykes, D. A.; Harris, S. J. (Univ. of Surrey, Guildford, Eng.). Nucl. Instrum. Methods; 97: No. 2, 203-5 (1971).

Measurements were made of the energy straggling of ^{252}Cf fission fragments through air using a heavy-ion surface-barrier detector. Analysis of the energy spectra of the heavy and light fragments shows a decreasing energy straggling with increasing absorber thickness. This and other spectra parameters are explained by reference to stopping-power data for fission fragments. (auth)

7699 EFFECT OF MULTIPLE SCATTERING ON POSITRON-ELECTRON RANGES. Batra, R. K.; Grover, R. C.; Sehgal, M. L. (Aligarh Muslim Univ., India). pp 117-20 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

7700 COMPTON SCATTERING BY K-SHELL ELECTRONS AT LARGE SCATTERING ANGLE. Krishna Reddy, D. V.; Govinda Reddy, V.; Murty, D. S. R. (Osmania Univ., Hyderabad, India). pp 173-6 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

7701 INELASTIC SCATTERING OF GAMMA RAYS BY K-SHELL ELECTRONS. Krishna Reddy, D. V.; Narasimhacharyulu, E.; Murty, D. S. R. (Osmania Univ., Hyderabad, India). pp 177-81 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

7702 ANALYTICAL FORMULATION OF K-SHELL PHOTOEFFECT. Biswas, M.; Roy, S. C.; Ghose, A. M. (Bose Inst., Calcutta). pp 183-6 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

7703 COMPTON SCATTERING BY K-SHELL ELECTRONS AT 1.12 MeV. Baba Prasad, P. N.; Kane, P. P. (Indian Inst. of Tech., Bombay). pp 187-91 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

7704 EFFECT OF ABSORBER THICKNESS ON NARROW-BEAM-COLLIMATED GEOMETRY CONDITION. Gopal, S.; Sanjeevaiah, H.; Sanjeevaiah, B. (Univ. of Mysore, India). pp 513-17 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

7705 CALCULATION OF ELECTRON SLOWING-DOWN SPECTRA. I. HARD SPHERE CROSS SECTIONS. Sherman, Charles H.; Gordon, Nan E. (Parke Mathematical Labs., Inc., Carlisle, Mass.). Health Phys.; 21: No. 6, 733-41(Dec 1971).

Hard-sphere cross sections were used for calculating electron slowing-down spectra as a simple way of finding a first approximation to the effects of electron binding. The main effect was an increase of flux at low energy in the vicinity of the binding energies, which qualitatively tended to reduce the main disagreement between measurements and previous calculations. However, the hard-sphere cross section is quantitatively inadequate for electron slowing-down calculations as shown by a specific comparison with experimental results. (auth)

7706 CALCULATION OF ELECTRON SLOWING-DOWN SPECTRA. II. CLASSICAL CROSS SECTIONS. Sherman, Charles H.; Gordon, Nan E. (Parke Mathematical Labs., Inc., Carlisle, Mass.). Health Phys.; 21: No. 6, 743-53(Dec 1971).

Classical Coulomb cross sections, which make approximate allowance for binding of the atomic electrons, were used for calculating electron slowing-down spectra. The main result of binding is to increase the flux at low energy, which improves agreement with experiment. Calculations were made for four specific cases of beta sources in aluminum, copper, and gold for which experimental results were available. In a simplified, empirical version of the theory it was found that the calculations were in reasonable agreement with experiment down to about 300 eV for all three metals. However, attempts to improve the results by more detailed consideration of the electronic structure of the metals showed that the particular classical model on which these cross sections are based was not adequate. (auth)

7707 EMPIRICAL EQUATION FOR THE AVERAGE ENERGY-LOSS FRACTION OF BACKSCATTERED ELECTRONS. Tabata, Tatsuo; Ito, Rinsuke; Okabe, Shigeru (Radiation Center of Osaka Prefecture, Sakai, Japan). Jap. J. Appl. Phys.; 10: No. 12, 1729(Dec 1971).

An empirical equation is presented for the average energy-loss fraction of all the electrons scattered into the backward hemisphere for the case of perpendicular incidence: $\langle \Delta T \rangle / T_0 = a_1(T_0/m_0c^2)^{a_2} + a_3(T_0/m_0c^2)^{-a_4}$, where T_0 = incident kinetic energy and the a_i's = constants for a given target. Values of a_i are tabulated for target atomic numbers of Z = 13, 26, and 78 to 82. (D.L.C.)

7708 EMPIRICAL EQUATIONS FOR THE RANGE OF ELECTRONS. Tabata, Tatsuo (Radiation Center of Osaka Prefecture, Sakai, Japan); Ito, Rinsuke; Okabe, Shigeru; Fujita, Yoshiaki. Hoshasen Butsuri Kenkyu; 3: No. 2, 1-13 (Apr 1970). (In Japanese).

From the analysis of experimental results on the range of electrons of energies from 4 to 24 MeV, various empirical equations were obtained. The practical range R_p of electrons in this energy region was found to obey an empirical equation of the form $R_p = A(E_0 - B)^C$, where E_0 is the energy of the incident electrons, and A, B, and C are expressed by simple functions of atomic number of the absorber. A semi-empirical equation previously proposed by one of the present authors to express the relation between the theoretical mean range L and the experimental mean projected range $\bar{R}$ was modified to show a better agreement with the experimental data. Empirical equations for the range distribution and the range straggling are also given. (auth) (Japan)

7709 DETERMINATION OF UNIQUE HVT INHERENT FILTRATION AND f FACTORS FROM MEASURED X-RAY SPECTRA. Balasubrahmanyam, V. (Radiation and Environmental Research Co., Munich). Health Phys.; 21: No. 6, 851-3(Dec 1971).

The characteristics of diagnostic x-ray beams were measured with a NaI(Tl) crystal. A Siemens Stabilipen (dc) constant potential tube was used, (50 to 250 kV, tube currents from 2 to 15 mA, tungsten target at 45°, and with 2-mm Al equivalent inherent filtration). The half-value thicknesses (HVT) of the x-ray beams spectrally analyzed were also determined by the conventional absorption method using ionization chambers, and unique HVT's were deduced from measurements made for various areas of irradiation by extrapolation to zero area. Good agreement was obtained between the HVT's (spectrometer) and HVT's (unique). Three different methods of estimating inherent filtration were also in agreement. The f factors (rad/Roentgen) for epidermis, bone, and muscle were deduced from the measured spectral fluence. (UK)

7710 SLOWING DOWN OF 6.620-MeV α PARTICLES IN GASEOUS ABSORBENTS (Ne, Ar, Kr) FOR SMALL ENERGY LOSSES. Dolle, F. (CNRS Mulhouse, France); Schultz, J.; Chevallier, P.; Sutter, G. J. Phys. (Paris); 32: Nos. 5–6, 397-403(May 1971). (In French).

The slowing down and straggling of 6.620-MeV α particles in the rare gases, Ne, Ar, and Kr were studied. The comparison of the experimental results with those calculated by Bethe and Symon demonstrated that the experimental values at small energy loss are in good agreement with theoretical predictions of Symon. (auth)

Shielding

7711 NEUTRON TRANSMISSION THROUGH AIR-FILLED DUCTS IN WATER SHIELDS. Mohammed, F.; Belov, S.; Megahid, R.; Hamouda, I. (Atomic Energy Establishment, Inshas, Egypt). Isotope Radiat. Res.; 4: 1-7(Jun 1971).

The thermal neutron flux distributions were measured along the axes of hollow cylindrical air-filled ducts of diameters D = 29, 58, 100 mm. The ducts were placed in a water-filled tank positioned at one of the horizontal beam channels of the UA–RR–1 reactor so that the duct axis was perpendicular to the beam axis. The distributions obtained were approximated by exponential functions of the distance along the duct axis. The duct effect, defined as the ratio of the neutron flux at a point on its axis to the neutron flux in water at the same place when the duct is filled with water, was approximately described by an exponential with a parameter depending upon $D^{0.75}$. (auth)

Solid-State Physics

Refer also to abstract 7826.

7712 (STI/PUB–270) THEORY OF IMPERFECT CRYSTALLINE SOLIDS: TRIESTE LECTURES 1970. Lectures Presented at an International Course, Trieste, January 12–April 10, 1970. (International Atomic Energy Agency, Vienna (Austria)). Jul 1971. 610p.

Twelve lectures are included: quantum-mechanical techniques, dislocation theory, electron transport phenomena, theory of impurity states, scattering and resonant states in crystals, spectroscopy of localized states, thermodynamics and kinetics of point defects, basic theory of semiconductor devices, electron theory of alloys, quantum theory at surfaces and interfaces, radiation damage, and order–disorder theory. A separate abstract was prepared for the lecture on radiation damage. (D.L.C.)

For an abstract of an individual section see: 7719.

Radiation Effects

Refer also to abstracts 6585 and 6606.

7713 (ORO–3651-10) RADIATION EFFECTS ON GERMANIUM. Final Report. Gossick, B. R. (Kentucky Univ., Lexington. Dept. of Physics and Astronomy). Feb 1971. Contract AT-(40-1)-3651. 8p. Dep. NTIS.

Studies were made of the influence of fast-neutron bombardment on the transport properties of carriers in n-type Ge. An rf method was developed for measuring the ambipolar diffusion coefficient in intrinsic or near-intrinsic materials. (D.L.C.)

7714 COMPUTER SIMULATION OF THE PENETRATION OF LOW-ENERGY Kr IONS INTO SINGLE-CRYSTAL TUNGSTEN. Pryde, M. (Liverpool Polytechnic); Smith, A. G.; Carter, G. J. Phys., D (London); 4: No. 11, 1681-6(Nov 1971).

Computers were used to follow the trajectory of Kr ions striking a simulated tungsten single crystal. The crystal faces chosen were the (100) and (110) and the effect of the second plane of atoms below the surface was included. From a study of the ion trajectories, probability of ion penetration into the surface was determined and values are compared with experimental data. (auth)

7715 LINE STRUCTURE IN THE CONTINUOUS X-RAY SPECTRUM: A CRYSTALLOGRAPHIC APPROACH IN THE KINEMATIC APPROXIMATION. Elliott, J. A. (Univ. of Manchester, Eng.). J. Phys., C (London); 4: No. 15, 2258-65(28 Oct 1971).

The bremsstrahlung from a single-crystal target under electron bombardment is not continuous, but consists of a large number of discrete lines arising because the scattering potential is periodic. Classical and Born approximation calculations yield the same expressions for the line intensities in the nonrelativistic case. The electron scattering is inelastic but coherent, the degree of coherence being determined by the Debye–Waller temperature factor. The line width is about 10 eV. (auth)

7716 METHOD FOR PRODUCING PASSIVATED PN JUNCTIONS BY ION BEAM IMPLANTATION. Lepselter, Martin P.; Waggener, Herbert A. (to Bell Telephone Labs., Inc.). U. S. Patent 3,615,874. 26 Oct 1971. Filed 15 Sep 1969.

A method is given for producing tucked-under, passivated PN junctions in semiconductor devices by ion implantation through a layered mask. The mask comprises a first relatively thin dielectric layer and a conductive layer thereover. An aperture is formed in the conductive layer, and the structure is subjected to a beam of dopant ions having energy sufficient to penetrate the dielectric layer but insufficient to penetrate the combined layers. In this fashion a PN junction is formed in the semiconductor body underneath the aperture in the conductive layer. Then the conductive layer is caused to become thicker, e.g., by electroplating, which also causes the aperture in the second layer to become smaller in lateral dimension. Then, using the conductive layer as a mask, the portion of the dielectric layer exposed through the aperture is selectively removed, e.g., by backsputtering. In this manner there is exposed a portion of the surface that is smaller than the implanted zone. (auth)

7717 METHOD FOR FABRICATING SEMICONDUCTOR DEVICES BY ION IMPLANTATION. Morita, Todahisa; Tokyuama, Takashi; Tsuchimoto, Takashi; (and others). (to Hitachi, Ltd.). U. S. Patent 3,615,875. 26 Oct 1971. Priority date 30 Sep 1968, Japan.

A method is given for forming a PN junction having a partially projected area, and without the defects from the emitter dip phenomenon. In the method a predetermined surface area is bombarded at an unchanneling (blocking?) angle by inert ions of one conductivity type to produce a thin amorphous layer, and a larger area encompassing the above area is bombarded by active ions of opposite conductivity type at a channeling angle. A PN junction is formed with a partial projection at its bottom face, which may be used as a transistor. The method works best with the [110] face of silicon. (D.L.C.)

7718 ION BEAM TARGET THAT DISTRIBUTES IRRADIATION DAMAGE UNIFORMLY IN DEPTH WITH TEMPERATURE CONTROL. Worth, J. H.; Clark, P. A.; Hudson, J. A. (Atomic Energy Research Establishment, Harwell, Eng.). J. Brit. Nucl. Soc.; 10: No. 4, 329-33(Oct 1971).

The techniques for producing displacement damage in materials by bombarding with beams of energetic charged particles are well known. A fundamental limitation found in such experiments is the increasing intensity of displacement damage along the track of an ion, leading to a peak of damage density near the end of its range. A target apparatus is described that oscillates the sample of material during irradiation about an axis perpendicular to the direction of the ion beam. The angular motion is designed to eliminate the damage peak and give a zone of nearly constant damage density along the path of the particle. The law relating dose and angle of rotation is discussed, and results are given for 20-MeV carbon ions bombarding steel and nickel. The impetus for the development of such a target apparatus came from the need to simulate the phenomenon of void formation in structural and cladding materials irradiated in a fast reactor. As this phenomenon is temperature-sensitive, a method of controlling the irradiation temperature was evolved, based on a heater with good thermal conductivity; this heater is described. An oscillating target may also be used when it is required to implant ions uniformly in depth. The use of this apparatus, for such a purpose, is also discussed. (auth)

7719 RADIATION DAMAGE. Thompson, M. W. pp 535-63 of Theory of Imperfect Crystalline Solids. Vienna; International Atomic Energy Agency (1971).

See STI/PUB–270.

A review of theoretical and experimental achievements and problems in the field of radiation damage is given. The presentation includes diagrams, examples, and concise formulations rather than detailed derivations. 10 references. (auth)

7720 EPR OF Ti^{3+} CENTERS IN α-QUARTZ. Okada, M.; Rinneberg, H.; Weil, J. A.; Wright, P. M. (Argonne National Lab., Ill.). Chem. Phys. Lett.; 11: No. 3, 275-6(15 Oct 1971).

EPR studies of several new charge-compensated Ti^{3+} centers produced by x irradiation in α-quartz are reported. (auth)

7721 RADIATION-ENHANCED DIFFUSION IN METALS: ORDERING IN ANNEALED SILVER–ZINC ALLOYS. Bystrov, L. N.; Ivanov, L. I.; Platov, Yu. M. (Inst. of Metallurgy, Moscow). Phys. Status Solidi (a); 7: No. 2, 617-27(16 Oct 1971).

By the method of resistivity measurement at –197°C, ordering in the annealed Ag – 8.75 at. % Zn alloy samples was investigated under 2.3-MeV electron irradiation at temperatures from –20 to +190°C and electron fluxes from 9.35×10^{12} to 4.66×10^{13} cm^{-2} sec^{-1}. The resistivity change during the ordering was found to obey second-order kinetics. The temperature dependence of the radiation-enhanced diffusion coefficient is described by an exponential with an activation energy of 0.41 eV. The diffusion coefficient varies as the square root of electron fluxes. Analysis of the results obtained led to a conclusion that in a well-annealed metal (small concentration of dislocations), the radiation-enhanced diffusion is steady. Annihilation of interstitials and vacancies is the diffusion-controlling process, the motion of interstitials in the dumbbell configuration being responsible for contribution to the diffusion flow. (auth)

7722 EFFECT OF REACTOR IRRADIATION ON THE ELECTRICAL PROPERTIES OF AMORPHOUS GERMANIUM. Tiainen, O. J. A. (Helsinki Univ. of Tech.). Phys. Status Solidi (a); 7: No. 2, 583-91(16 Oct 1971).

The effect of reactor irradiation on the electrical properties of thin films of amorphous germanium has been studied. The temperature during irradiation periods was 320°K. The temperature dependence of dc resistivity was measured before and after heat treatment and irradiation periods. The resistivity measurements were supplemented by measuring the capacitance and the dielectric loss factor at 77°K of thin-film capacitors made of the same material. Irradiation was found to decrease the resistivity of heat-treated germanium thin films, at the same time increasing the dielectric losses of thin film capacitors made of the same material. (auth)

7723 CHANNELLING OF PROTONS IN A SINGLE CRYSTAL OF SILICON. Prasad, K. G.; Sharma, R. P.; Srivastava, J. K. (Tata Inst. of Fundamental Research, Bombay). pp 503-6 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

7724 EFFECT OF THE CONCENTRATION OF PHOSPHORUS IN SILICON ON THE RATE OF GENERATION OF RADIATION DEFECTS IN BOMBARDMENT WITH REACTOR NEUTRONS. Vavilov, V. S.; Uvarov, E. F.; Chukichev, M. V. (Moscow State Univ.). Sov. Phys.-Semicond. (Engl. Transl.); 3: No. 12, 1557-61(Jun 1970).

Translated from Fiz. Tekh. Poluprov.; 3: No. 12, 1838-42 (Dec 1969).

The rate of generation of E centers was found to increase sublinearly with increasing concentration of phosphorus in n-type silicon grown by pulling from a quartz crucible or by zone melting. This rate was higher in the zone-melted material than in the crystals pulled from a quartz crucible. The rate of generation of A centers was independent of the concentration of phosphorus in the crystals pulled from a quartz crucible and showed only a weak dependence on the concentration of phosphorus in the zone-melted material. The irradiation temperature affected considerably the efficiency of generation of the A and E centers. The spin degeneracy factors of the A and E levels in silicon were shown to be equal to two. (auth)

7725 LATTICE PARAMETERS OF ION-IMPLANTED SILICON CRYSTALS. Mitsuishi, Tomokuni; Kishino, Seigo; Noda, Atsuko (Hitachi Ltd., Tokyo). Jap. J. Appl. Phys.; 10: No. 12, 1734-5(Dec 1971).

One side of Si(111) wafers was implanted with B ions at 100 keV and 10^{16} ions/cm^2. Specimens were cut and annealed at 500 and 1000°C for 10 min, and the carrier density was obtained from sheet-resistivity measurements. The lattice parameter was determined from bending curvature, and the profile of the carrier density calculated from the lattice parameter change was compared with that from sheet resistivity. Reasons for the disagreement between the two profiles are discussed. (D.L.C.)

7726 EPR AND OPTICAL INVESTIGATIONS OF NEUTRAL SILVER ATOMS IN KBr AND KI CRYSTALS. Mel'nikov, N. I.; Zhitnikov, R. A.; Baranov, P. G. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 5, 1117-22(Nov 1971).

Translated from Fiz. Tverd. Tela; 13: No. 5, 1337-44(May 1971).

Neutral silver atoms were found in KBr : Ag and KI : Ag crystals irradiated by x rays at 77°K. These atoms were studied by EPR and optical spectroscopy. The interpretation of the results is discussed. (auth)

7727 CHARGE CARRIER MOBILITIES IN IRRADIATED PURE AND TETRACENE DOPED ANTHRACENE CRYSTALS. Krisch, O. (Univ., Giessen, Ger.). Z. Phys.; 248: No. 2, 185-94(1971). (In German).

The influence of a 50-kV x-ray pre-irradiation on the behavior of the electron- and hole-photocurrents has been investigated by a transient photoconduction technique (Kepler and Le Blanc). From the results, some conclusions can be drawn about the quantity and the nature of the x-ray-induced defects. (auth)

7728 LUMINESCENCE FROM CALCITE SINGLE CRYSTALS IRRADIATED AT 4.2 K. Cunningham, Joseph (Univ. of Notre Dame, Ind. University Coll., Dublin). Int. J. Radiat. Phys. Chem.; 3: No. 4, 467-81(Dec 1971). (CCO–38–704).

Intensity and extent of polarization of radiation-induced luminescence from single crystals of calcite were examined at temperatures 4.2 to 150°K. In radioluminescence at 4.2°K, β particles of average energy 18 keV from ^{63}Ni stimulated only one photon per 10^5 eV absorbed. Charges trapped during irradiation at 4.2°K yielded post-radiation luminescence with similarly low overall efficiency when warmed to 120°K. After irradiation by ^{60}Co γ rays at 4.2°K, an afterglow decaying by first-order kinetics with $t_{1/2}$ = 4500 sec at temperatures 4.2 to 30°K was observed, followed by a broad thermoluminescent emission extending 35 to 110°K. Temperature dependence of thermoluminescence indicated thermal release of holes from traps of effective depths increasing from 0.018 to 0.04 eV as temperature increased 35 to 77°K. Isothermal decay of intensity of thermoluminescence at 77°K after irradiation at that temperature obeyed second-order kinetics. Extent of polarization of thermoluminescence increased at temperatures 77 to 90°K. Results are compared with requirements of mechanisms involving emission from impurity-activated regions of the lattice stimulated when holes recombine with electron-excess centers, via tunnelling or auto-ionization at 4.2°K, but via thermally activated release of holes from shallow traps for temperatures 35 to 110°K. Temperature dependence of the polarization of thermoluminescence is tentatively accounted for in terms of hole-equilibration between valence bands (or quasi-localized energy levels) of differing symmetries and energies. (auth)

7729 STRESS RELAXATION IN GAMMA-IRRADIATED CRYSTALS OF NaCl AND KCl. Makara, V. A.; Novikov, N. N. (Kiev State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 7, 1219-21(Jul 1971). (In Russian).

Stress relaxation was determined in unirradiated and in γ-irradiated NaCl and KCl. The method used relaxation curves and necessitated the measurement of the activation volume of dislocation movement in these crystals. The values obtained for the activation volumes in the unirradiated crystals and their changes with increasing dose of γ radiation agreed with data from the literature. (tr-auth)

7730 RELATIONSHIP BETWEEN ACOUSTIC EMISSION AND DISLOCATION KINETICS IN CRYSTALLINE SOLIDS. James, Darrell R. (Air Force Weapons Lab., Kirtland AFB, N. Mex.); Carpenter, Steve H. J. Appl. Phys.; 42: No. 12, 4685-97(Nov 1971).

The sounds emitted from single crystals of irradiated LiF, annealed LiF, NaCl, and zinc during constant-strain-rate compressive deformation were recorded and analyzed. The acoustic emission consisted of discrete pulses of varying amplitudes, and the rate of pulsing changed with total strain during the continuous deformation experiments. A reasonable correlation between acoustic-emission pulse rate and the rate of change of mobile dislocation density was found and led to the conclusion that the pulses were generated by dislocation breakaway from pinning points. The measured dislocation densities were used to estimate that several thousand centimeters of dislocation line length had been involved in the generation of an individual acoustic pulse. It was suggested that some 10^5–10^6 segments of dislocation line were involved in a cumulative fashion due to the stimulating effect of the moving acoustic wave on bowed dislocation segments. The concept of stimulated dislocation breakaway from pinning points appeared to be a reasonable model to explain the acoustic results of this study and may provide the fundamental basis for explaining discontinuous plastic flow, jerky dislocation motion, slip line broadening, and other features of crystal plasticity. (auth)

7731 VARIATIONS OF THE DISLOCATION DAMPING COEFFICIENT DURING GAMMA IRRADIATION OF NaCl SINGLE CRYSTALS. **Bielig, G. A. (Univ. of New South Wales, Kensington, Australia). J. Appl. Phys.; 42: No. 12, 4758-63(Nov 1971).**

Deformed sodium chloride crystals were irradiated by γ rays from spent fuel elements while their ultrasonic properties (resonant frequency and decrement) were being measured. It was found that the damping coefficient associated with the viscous drag on a moving dislocation varied with time during irradiation, and was also a function of the state of deformation of the crystal. The variations in the damping coefficient were interpreted in terms of the model developed by Robinson and Birnbaum for dislocation damping in alkali halides. (auth)

7732 DEFECT CENTERS IN BORON-IMPLANTED SILICON. **Chan, W. W.; Sah, C. T. (Univ. of Illinois, Urbana). J. Appl. Phys.; 42: No. 12, 4768-73(Nov 1971).**

Deep-level defect centers in the upper half of the energy gap, created by 70-keV and subsequent 150-keV boron ions implanted into n-type (111)-oriented silicon crystals at room temperature, were investigated using the dark capacitance transient technique. Two independent centers with thermal ionization energy for electrons of 241 ± 8 and 558 ± 6 meV are found. Thermal emission rates of electrons at these centers depend slightly on the applied field. For annealing temperature up to 450°C, the postimplantation annealing rates vary from 10^{-4}/cm to 10^{-3}/cm for both levels (defect concentration $\sim 10^{12}$ to $10^{13}/\text{cm}^3$). The defects are annealed out ($<10^{-4}$/cm) above 600°C. The thermal activation energy and the preexponential factor in the emission rate are essentially independent of annealing temperature and no new centers are detected after each annealing step. Low junction leakage ($0.2\ \mu\text{A/cm}^2$ at -10 V) is observed for all samples obtained prior to and after annealing. (auth)

7733 EFFECT OF TEMPERATURE AND ELECTRIC FIELD STRENGTH ON THE IONIZATION CONDUCTIVITY OF LIQUID AND SOLID CYCLOHEXANE. **Jachym, B.; Polak, H. (Technical Univ., Danzig). Acta Phys. Pol.; A40: No. 5, 655-9(Nov 1971).**

The ionization currents induced by ^{137}Cs gamma rays were measured in a plane-parallel ionization chamber. Measurements were carried out in the -30 to 40°C temperature range. The buildup time of the current, from the instant ionization is switched on to achievement of a fixed value, is about 10^3 times longer in solid cyclohexane than in the liquid form. The shapes of the current–voltage characteristics are similar for both the solid and liquid cyclohexane forms, but the ionization currents measured in the liquid are some two times higher than the corresponding currents in the solid. In both the liquid and the solid, the ionization current increases with increasing temperature. Calculated values of thermal activation energies are lower in the liquid, $W_L \sim 0.05$ eV, than in the solid state, $W_S \sim 0.3$ eV. With increasing electric field strength, the activation energy decreases in both solid and liquid cyclohexane. (auth)

7734 EFFECT OF FAST-NEUTRON IRRADIATION ON THE SATURATION REMANENCE OF A BASALT. **Soffel, H. (Univ., Munich). Z. Geophys.; 37: No. 3, 519-23(Sep 1971).**

The saturation remanence $J_{\text{sat.rm.}}$ of a basalt sample from Rauher Kulm (Germany) containing homogeneous and mostly multidomain titanomagnetites and its decrease with ac demagnetization up to 700 Oe effective field was measured before and after radiation with fast neutrons (1 to 10 MeV) with a flux density of 2×10^{12} n/cm^2. With the exception of the ac demagnetization range from 0 to 10 Oe, where $J_{\text{sat.rm.}}$ after radiation was about 1% larger than before radiation, no change of the demagnetization curves could be detected. This suggests that essentially higher flux rates of fast neutrons or other particles are necessary to produce an appreciable increase of the coercive force of titanomagnetites in basalts and to contribute to a "hardening" of viscous remanent magnetization. (auth)

Physical Properties

Refer also to abstract 7170.

7735 EFFECT OF PRESSURE ON THE MAGNETIC SUSCEPTIBILITY OF TITANIUM–VANADIUM AND VANADIUM–CHROMIUM ALLOYS. **Panfilov, A. S.; Svechkarev, I. V. Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 61: No. 3, 1087-91(Sep 1971). (In Russian).**

The effect of hydrostatic pressure up to 4000 kg/cm^2 on the magnetic susceptibility of titanium–vanadium and vanadium–chromium alloys was investigated at room temperature. It was found that the main mechanism of alteration of the spectrum that determines the behavior of the alloy system susceptibility under pressure is deformation of the d-band. (auth)

7736 THERMALLY STIMULATED EXOELECTRON EMISSION (TSEE) CAUSED BY PRESSURE LOADS ON BeO CERAMIC. **Brunsmann, U.; Euler, M.; Kriegseis, W.; Scharmann, A. (Univ., Giessen, Ger.). Phys. Status Solidi (a); 7: No. 2, K91-3(16 Oct 1971).**

The effects of mechanical strain, induced by a hydraulic press at pressures from 2000 to 8000 kp/cm^2, on the TSEE of Thermalox 995 (sintered BeO) were studied. All the curves show glow peaks at the same temperature of 250°C, regardless of the pressure used (x irradiation shifts the peak to 265°C). The relation between pressure and TSEE intensity is nearly linear, indicating that TSEE is a possible method for measuring pressure loads. (D.L.C.)

7737 Te-CONCENTRATION DEPENDENCE OF THE EMISSION INTENSITY OF CdS:Te BY RADIOACTIVE-TRACER PROFILE TECHNIQUE. **Goede, O. (Humboldt-Univ., Berlin); Nebauer, E. Phys. Status Solidi (a); 7: No. 2, K85-7(16 Oct 1971).**

A parallelpiped-shaped CdS single crystal was annealed in a Te atmosphere enriched in ^{127m}Te to produce a Te gradient, and the uv-excited emission intensity at 2.05 eV and the Te concentration were measured using microtome sectioning. The results show a linear relationship between the emission intensity and the Te concentration in the range 5×10^{17} to 4×10^{19} cm^{-3}. The emission is due to Te centers which are isolated Te atoms. (D.L.C.)

7738 COMBINATION OF AUGER SPECTROSCOPY AND CHARACTERISTIC LOSS SPECTROSCOPY FOR THE ELEMENTS V TO Co. **Coad, J. P. (Oxford Univ.); Riviere, J. C. Phys. Status Solidi (a); 7: No. 2, 571-5(16 Oct 1971).**

Splitting of the $M_{2,3}$ characteristic loss peak was observed following oxidation of clean Cr and V surfaces, but not after oxidation of Fe and Co, although in all four cases the Auger spectra were characteristic of an oxidized surface. In addition, even when the Cr Auger spectrum indicated a clean surface, the $M_{2,3}$ loss peak was found to have a position and width different from those expected for a clean metal. The results are explained on the assumption of different ranges for electrons of different origins. (auth)

7739 SUPERFERROMAGNETISM IN THIN Gd AND Gd–Au FILMS. **Bostanjoglo, O.; Roehkel, K. (Technische Univ., Berlin). Phys. Status Solidi (a); 7: No. 2, 387-92(16 Oct 1971).**

Polycrystalline ferromagnetic Gd and Gd–Au films are built up of clusters, the atomic spins being exchange-coupled. At low temperatures, the clusters are coupled almost exclusively by magnetostatic forces. In this superferromagnetic state the usual large magnetic domains show up. At a critical temperature well below the Curie point, the magnetic long-range order is destroyed and the usual magnetic domains vanish. A short-range order comprising several aligned neighboring clusters, however, persists up to the Curie point. These short-range aligned clusters form microdomains with an average diameter of 200 Å, the cluster diameter being of the order of the crystal size. (auth)

7740 SHUBNIKOV–DE HAAS EFFECT AND MAGNETIC BREAKDOWN IN Be. **Sellmyer, D. J.; Goldstein, I. S.; Averbach, B. L. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., B; 4: No. 12, 4628-31(15 Dec 1971).**

Magnetic breakdown in the basal plane of Be was investigated in fields up to 150 kG. Geometrical aspects of the open orbits caused by breakdown are discussed. An estimate of 30 kG for the characteristic breakdown field is obtained by applying the theory of Falicov et al. Shubnikov–de Haas frequency measurements are reported for the central-cigar cross section. These measurements are relevant to a recent conjecture that the Onsager–Lifshitz quantization scheme may be violated in the presence of magnetic breakdown. (auth)

7741 MAGNETIC PROPERTIES OF TUNGSTEN HARD ALLOYS AT ELEVATED TEMPERATURES. **Tumanov, V. I.; Korchakova, E. A.; Elmanova, S. M. (All-Union Scientific-Research Inst. of Hard Alloys, Moscow). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 5, 415-17(May 1971).**

Translated from Porosh. Met., Akad. Nauk Ukr. SSR.; 10: No. 5, 87-90(May 1971).

Studies were made on the effects of temperature on the coercive force of WC–Co alloys with different amounts of Co, and the Curie temperature and chemical composition (W content) of the

Co solid solution in alloys differing in Co content and grain size. The results showed that the coercive force of the alloys decreased with rise in test temperature. The character of the coercive force variation was not linear. The curves exhibited an inflection at temperatures of 400 to 500°C. At a temperature of 900°C, the coercive force of all the alloys investigated was found to reach a very low value of the order of 2 to 3 Oe. The Curie temperature for Co agreed with literature data. The W content of the cementing phase in the two-phase alloys investigated varied within wide limits, from 5 to 20 wt %, which is linked with the technological characteristics of their preparation. (P.C.H.)

7742 OBSERVATION OF EPITAXIAL MULTICRYSTALLINE DEPOSITS OF GOLD BY THE CHANNELING AND SHADOW METHOD. Markus, A. M.; Geguzin, Ya. E.; Fainshtein, A. L. (Physical-Technical Inst., Kharkov). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 5, 1232-3(Nov 1971).

Translated from Fiz. Tverd. Tela; 13: No. 5, 1476-8(May 1971).

The multicrystallinity of Au epitaxial films deposited on NaCl (100) surfaces was revealed by observing proton-diffraction patterns "in transmission" so that a shadow pattern is obtained. All four possible orientations of the Au film with respect to the NaCl (100) plane were represented. When the ⟨110⟩ channels were parallel to the proton beam, the $I_k = f(\varphi)$ curve exhibits 12 peaks on rotation of the film through 360°. (D.L.C.)

7743 MAGNETIC AND OPTICAL PROPERTIES OF Eu^{3+} AND Sm^{3+}. Krylov, E. I.; Makurin, Yu. N.; Kasimov, G. G. (Ural Polytechnic Inst., Sverdlovsk, USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 5, 1271-2(Nov 1971).

Translated from Fiz. Tverd. Tela; 13: No. 5, 1513-14(May 1971).

The energy difference ΔE between the first excited and the ground J levels is calculated from the magnetic properties to be 250 cm^{-1} for Eu^{3+} and 1020 cm^{-1} for Sm^{3+}. These values are below those obtained from spectroscopic data, 400 and 1100 cm^{-1}, respectively. This discrepancy is explained as being due to a disturbance of the interference of microstates from the constant magnetic field, which leads to a decrease in ΔE. Fading of the interference can be described by the correlation function $\exp(-t/T)$; thus, a magnetic ΔE of 990 cm^{-1} is calculated for Sm. (D.L.C.)

7744 INTERACTION BETWEEN PROTON TUNNELING AND OPTICAL PHONONS IN KH_2PO_4. Nettleton, R. E. (Sandia Labs., Albuquerque, N. Mex.). Z. Phys.; 248: No. 2, 101-10 (1971).

The atomic motions that determine spontaneous polarization P_s in clamped KH_2PO_4 or KD_2PO_4 are assumed to be tunneling of protons between minima of a double-well H-bond potential, coupled to phonons belonging to the lowest transverse optic branch. The configuration Hamiltonian H_p of the protons is written in Ising spin representation, and mixed spin-phonon energies are obtained by using the linearized equation-of-motion method, the lowest of these energies diminishing as $T \to T_c$, in agreement with Raman measurements. The mixed-mode energies depend on $\langle Z \rangle$, the degree of proton order. By differentiating the self-consistent equation for $\langle Z \rangle$, one can show $dP_s/dT \to -\infty$ at a point T_c where $P_s > 0$, so that the transition is first-order. T_c thus identified can be expanded in powers of Γ, and it is found that if the expansion converges rapidly, the spin–phonon coupling should diminish the isotope effect on T_c and contribute positively to the dependence of P_s at 0°K on tunneling factor Γ. (auth)

7745 MAGNETIC SUSCEPTIBILITY OF CERIUM–THORIUM ALLOYS. Francillon, Monique (CNRS, Meudon, France); Gorochov, Ouri. Compt. Rend., Ser. C; 273: No. 15, 898-901 (11 Oct 1971). (In French).

New magnetic transitions were observed in cerium–thorium alloys. The alloy containing 25 at. % thorium has a maximum susceptibility at about 170°K. (France)

7746 DEPENDENCE OF WORK FUNCTION ON DEGREE OF COVERAGE OF ALKALINE METALS ADSORBED ON TUNGSTEN. Sidorski, Z.; Wojciechowski, K. F. (Wroclaw Univ.). Acta Phys. Pol.; A40: No. 5, 661-73(Nov 1971).

A discussion is given of difficulties encountered when explaining the experimental dependence of the work function on the degree of coverage for alkali metals adsorbed on tungsten monocrystal planes, using existing theoretical models. For low coverages ($\theta <$ 0.5), a simple model is proposed that allows one to calculate the dependence of the adion charge on the degree of coverage. A decrease of this charge with increasing coverage has been obtained in agreement with experiment. For higher coverages ($0.6 \le \theta \le$ 1), it has been assumed from numerous experimental facts that the adsorbed layer shows properties of the solid metal with varying lattice constants. The band model allows one to obtain a formula describing the dependence of the work function on the degree of coverage that is in good agreement with experiment. (auth)

7747 ANGULAR CORRELATION MEASUREMENTS OF ANNIHILATION RADIATION IN ORDERED β BRASS. Triftshaeuser, W. (Queen's Univ., Kingston, Can.); Stewart, A. T.; Taylor, R. J. Phys. Chem. Solids; 32: No. 12, 2711-16(Dec 1971).

The angular correlation of radiation from positrons annihilating in β' CuZn single crystals was measured. The crystals were oriented in the (100), (110), and (111) directions and the measurements yield information intimately related to the areas of slices through the Fermi surface normal to these directions. These cross sections were obtained from a theoretical calculation by Taylor using results of de Haas–van Alphen measurements for β' CuZn. The experimental data are directly compared with these calculated values. A remarkably good agreement was found between theory and experiment, and most of the anisotropy in the electron momentum distribution can be ascribed to the topology of the Fermi surface. (auth)

7748 POSITRON ANNIHILATION ANGULAR CORRELATION MEASUREMENTS IN DISORDERED SYSTEMS: α BRASS. Triftshaeuser, W.; Stewart, A. T. (Queen's Univ., Kingston, Can.). J. Phys. Chem. Solids; 32: No. 12, 2717-22(Dec 1971).

Angular correlation measurements of positrons annihilating in αCuZn single crystals were performed. The orientation of the specimens was parallel to the (100), (110), and (111) directions. The results are compared with a model calculation for the Fermi surface of this alloy, assuming that every Zn atom adds two electrons to the total number of conduction electrons. The cross-sectional areas normal to the (100), (110), and (111) axes of the Fermi surface constructed in this way are compared with the experimental data. The experimental results were interpreted in terms of the topology of the Fermi surface according to the evidence and conclusions of Triftshaeusser et al. (J. Phys. Chem. Solids, 32: 2711(1971)). For a 77.7% Cu 22.3% Zn concentration alloy, a radius for the necks along the (111) directions of 0.27 ± 0.02 in units of the Fermi momentum was found. (auth)

7749 STRUCTURAL AND MAGNETIC STUDIES ON $ErFe_2$–$ErAl_2$. Oesterreicher, Hans (Oregon Graduate Center, Beaverton). J. Appl. Phys.; 42: No. 12, 5137-42(Nov 1971).

Specimens annealed at 1000°K are of C15 type from $ErFe_2$ to $Er_{0.333}Fe_{0.425}Al_{0.242}$, of C14 type from $Er_{0.333}Fe_{0.412}Al_{0.255}$ to $Er_{0.333}Fe_{0.237}Al_{0.430}$, and of C15 type from $Er_{0.333}Fe_{0.222}Al_{0.445}$ to $ErAl_2$. Magnetic investigations in the paramagnetic and ordered region show evidence for electron transfer to Fe from the trivalent ligands to the extent that Fe becomes nonmagnetic toward the Al-rich phase boundary of C14 ErFeAl. The materials order ferromagnetically on rare-earth sites, while Fe aligns antiparallel to the lanthanide. The saturation mechanism, however, is complex. Domain-wall effects, anisotropy, and the development of disordered magnetic components may be responsible for depressions in the saturation values of certain concentrations, stepwise increases of magnetization with field, and almost linear increases in magnetic moment in higher fields (10 to 47 kOe). (auth)

7750 LATTICE DYNAMICS OF Nb_3Sn-TYPE COMPOUNDS. Sham, L. J. (Univ. of California, San Diego, La Jolla). Phys. Rev. Lett.; 27: No. 25, 1725-8(20 Dec 1971).

It is shown that, in the cubic phase, the doubly degenerate Γ_{12} mode is the only long-wavelength optical mode that is temperature-dependent in the harmonic approximation. However, it does not become unstable on cooling because it would drive a shear acoustic mode unstable first. The elastic constants are calculated by the method of long waves. Only $C_{11} - C_{12}$ is temperature-dependent. Its calculated values for Nb_3Sn are in fair agreement with experiment. (auth)

7751 SCATTERING OF ELECTRONS BY VACANCIES THROUGH AN ORDER–DISORDER TRANSITION IN VANADIUM CARBIDE. Shacklette, L. W.; Williams, Wendell S. (Univ. of Illinois, Urbana). Contract AT(11-1)-1198. J. Appl. Phys.; 42: No. 12, 4698-4703(Nov 1971).

In nonstoichiometric vanadium carbide, the carbon-atom vacancies can be either ordered or disordered at certain compositions. It is likely that these vacancies in the disordered carbide are important electron scattering centers and produce the observed large residual resistivity. On the other hand, band-structure effects in the transition-metal carbides are sensitive to composition so it is difficult to evaluate the contribution of vacancies to the electrical resistivity. Since vacancy scattering should vanish in the ordered phase, the change in resistivity through the ordering temperature for $VC_{0.83} \rightarrow V_6C_5$ should be a useful measure. Such an experiment was performed. Though electron scattering by domain boundaries and by superlattice defects is important, the results show that vacancy scattering is indeed significant at low temperatures, but of lessening importance as temperature increases. (auth)

Moessbauer Effects and NMR

Refer also to abstracts 6903 and 8275.

7752 (UCRL–20426, pp 205-25) HYPERFINE INTERACTIONS. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1971.

From Nuclear chemistry.

Ten brief summaries are included in this section. Five are condensed from the published literature or UCRL reports, hence not included here. Those summaries not as yet reported elsewhere include: (1) ^{59}Co nuclear quadrupole interaction in $CoCl_2 \cdot 2H_2O$; (2) nuclear quadrupole moments of deformed $3/2^+$ states in ^{115}In and ^{117}In; (3) perturbed angular correlations in RuNi and RuFe; (4) ENDOR of Pu^{3+} in CaF_2; and (5) theoretical studies of the hyperfine structure of the SO_2 molecule, NO_2 radical, and N atom. (L.M.T.)

7753 HYPERFINE FIELD ON Tc IN Ni. Chopra, R. C.; Devare, S. H.; Devare, H. G. (Tata Inst. of Fundamental Research, Bombay). pp 667-71 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

7754 NMR IN MAGNETIC ^{59}Co FILMS. Salanskii, N. M.; Mal'tsev, V. K.; Lyapunov, I. A. (Inst. of Physics, Krasnoyarsk, USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 5, 1160-3(Nov 1971).

Translated from Fiz. Tverd. Tela; 13: No. 5, 1388-91(May 1971).

The spin-echo method was used to study nuclear magnetic resonance in magnetic ^{59}Co films. The amplification coefficient of the radio-frequency field depends strongly on the domain structure when a static magnetic reversal is induced. The dependence of the spin-echo signal on the external magnetic field was established for various orientations of the radio-frequency field with respect to the axis of the induced anisotropy. The influence of annealing on phase changes in the films was investigated. The relaxation times at the NMR frequencies of the β phase and a combination of the α and β phases were measured. (auth)

7755 HYPERFINE STRUCTURE ANOMALIES OF ^{67}Ga, ^{69}Ga, ^{71}Ga, ^{72}Ga, ^{113}In, ^{115}In, AND ^{117m}In. Lutz, O; Nolle, A.; Uhl, A. (Univ., Tuebingen, Ger.). Z Phys.; 248: No. 2, 159-61(1971).

The ratios of the g_I factors of ^{69}Ga and ^{71}Ga and of ^{113}In and ^{115}In were measured by the NMR method. By using hyperfine interaction constants from the literature, the hyperfine structure anomalies $^{67}\Delta^{69}$, $^{69}\Delta^{71}$, $^{71}\Delta^{72}$ of gallium and $^{113}\Delta^{115}$, $^{115}\Delta^{117m}$ of indium in the $^2P_{1/2}$ and $^2P_{3/2}$ atomic ground states are calculated. (auth)

Theory

7756 (ITF–71-72-E) INELASTIC COHERENT SCATTERING OF SLOW NEUTRONS BY THE LOCALIZED VIBRATIONS OF INTERSTITIAL ATOMS AND THE DETERMINATION OF FORCE-CONSTANT CHANGE DUE TO IMPURITY. Dzyub, I. P.; Kochmarskii, V. Z. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 28p. Dep. NTIS (U. S. Sales Only).

Inelastic coherent scattering of slow neutrons by the localized vibrations of interstitial atoms is considered. The possibility of obtaining information on the change of force-constant matrix by using the angular distribution of neutrons scattered by the localized vibrations is explored. It is shown that the investigation of odd-parity vibrations is of the greatest interest in this respect. Under certain conditions imposed on the change of force-constant matrix, it is possible to calculate with high accuracy the frequency of odd-parity localized vibrations and express the angular distribution of neutrons through the change of force-constant matrix. The results obtained are illustrated with numerical calculations for the impurities introduced into simple and fcc lattices. (auth)

Theoretical Physics

Refer also to abstracts 6828, 6894, 7501, and 8355.

7757 (DEMO–71/20) STATES, MINIMIZING THE UNCERTAINTY PRODUCTION OF THE OSCILLATOR PHASE OPERATORS. Ifantis, Evangelos K. (Democritus Nuclear Research Center, Athens (Greece)). Sep 1971. 26p. Dep. NTIS (U. S. Sales Only).

The normalizable states, that minimize the uncertainty product of the oscillator phase operators are determined and some of their physical properties are discussed. A physical classification of these states was made and the class of "analogous" states to the well known coherent states is physically defined. (auth)

7758 NEW METHOD FOR CONSTRUCTING SOLUTIONS TO TIME-DEPENDENT PERTURBATION EQUATIONS. Alexander, Millard H.; Gordon, Roy G. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys.; 55: No. 10, 4889-97(15 Nov 1971).

A method is developed for obtaining solutions to the usual first-order perturbation equations arising from the presence of a harmonic perturbation. By means of piecewise polynomial approximations to the unperturbed potential and to the perturbation, the method yields the first-order wave function in piecewise analytic form. It is easy to obtain error bounds to the relevant second-order properties. The method can be extended to multidimensional problems or to problems involving nonlocal potentials. Numerical application is made to the calculation of the frequency-dependent dipole polarizability of the hydrogen atom and of the helium atom within the uncoupled Hartree–Fock approximation. (auth)

7759 MODIFIED RAYLEIGH–SCHROEDINGER PERTURBATION EXPANSION. Rubinstejn, Francoise; Yaris, Robert (Washington Univ., St. Louis). J. Chem. Phys.; 55: No. 9, 4371-7(1 Nov 1971).

It is shown that a modified Rayleigh–Schrödinger perturbation series is invariant to arbitrary nonphysical changes in the choice of the unperturbed Hamiltonian and the perturbation while the standard Rayleigh–Schrödinger series is not. As an example of the use of the modified expansion and to demonstrate its improved convergence properties, a very limited-basis-set modified double-perturbation calculation of the polarizability of H_2 is presented, with the results being compared with both a standard double-perturbation calculation and the geometric approximation calculated using the same basis set. (auth)

7760 STATISTICAL DESCRIPTION OF QUANTUM SYSTEMS. Stenholm, Stig (Helsinki Univ. of Tech., Otaniemi, Finland). J. Statist. Phys.; 3: No. 4, 411-16(Winter 1971).

It is emphasized that the use of statistical methods is a consequence of the incomplete isolation of physical systems. The description of a partially specified quantum state by a density operator is shown to be equivalent to a description in terms of an ensemble of systems. Several definitions of the statistical operator are shown to be identical. (auth)

7761 COULD CLASSICAL STATES ALSO BE DISTRIBUTIONS WITH EXTENDED SUPPORTS. Shankara, T. S. (National Aeronautical Lab., Bangalore, India). Int. J. Theor. Phys.; 4: No. 6, 427-31(Oct 1971).

Unlike states in quantum mechanics or kinetic theory, it is generally believed that a classical state is a function with no spread; i.e., it does not involve any statistics. But a unified theory of dynamical processes suggests the plausibility of substituting for it the functional of error distribution. (auth) (UK)

7762 STARK EFFECT IN THE FIELD OF INCOHERENT RADIATION. Zusman, L. D.; Burshtein, A. I. (Inst. of Chemical Kinetics and Combustion, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz.; 61: No. 3, 976-88(Sep 1971). (In Russian).

The Stark effect produced by intense resonance radiation is investigated. It is demonstrated that the radiation statistics is manifest in the structure and shape of the spectrum observed for the adjacent transition. It is found that, from the shape of the spectrum, one can distinguish between amplitude and frequency modulation of the radiation and derive fundamental information from the experimental data regarding the statistics of photons in an incoherent field. (auth)

7763 CONSIDERATION OF PARTICLE EXCHANGE IN QUANTUM KINETIC THEORY. Lie, Tae-Journ; Liboff, Richard L. (Cornell Univ., Ithaca, N. Y.). Ann. Phys. (N.Y.); 67: No. 2, 349-75(Oct 1971).

A kinetic equation for a charged-particle system is derived in a dielectric-function formalism. Quantum effects of particle exchange are considered in a systematic way. In the limit of large k (large momentum transfer of ħk) the equation reduces to the Boltzmann equation, while in the small-k limit the Balescu–Guernsey–Lenard (BGL) equation appropriate to the random-phase approximation (RPA) is obtained. The dielectric constant derived in the present formalism reduces to the interpolation form obtained by Hubbard. In addition, the RPA kinetic theory is shown to reveal relaxation processes involving particle–excitation scattering as opposed to particle–particle scattering. An outline for formulating transport coefficients is included. (auth)

7764 GEOMETRICAL APPROACH TO THE HEISENBERG UNCERTAINTY RELATION AND ITS GENERALIZATION. Synge, J. L. (Dublin Inst. for Advanced Studies). Proc. Roy. Soc. (London), Ser. A; 325: No. 1561, 151-6(9 Nov 1971).

Real Hilbert space is a Euclidean space of infinite dimensionality. Complex Hilbert space is less amenable to elementary geometrical intuitions, but these do serve to give structure to the present argument. The familiar process of finding, relative to a vector x, the expectation $\overline{A}$ of a self-adjoint linear operator A, and then using the deviation $A - \overline{A}$ to obtain a dispersion ΔA, may be interpreted as a projection leading to a unit vector e orthogonal to x. If there are n self-adjoint operators A_r, n unit vectors e_r orthogonal to x are thus formed. From a basic property of Hilbert space, the vector $c_1e_1 + c_2e_2 + \ldots + c_ne_n$ has a non-negative norm for arbitrary complex coefficients. This demands the positive-indefinite character of a real quadratic form in 2n variables; equivalently, all its eigenvalues must be non-negative. This leads to inequalities on the dispersions ΔA_r, the expectations of the commutators $i[A_r,A_s]$ and other expectations. For n = 2, this process leads to Schroedinger's improvement of the Heisenberg inequality. The case n = 3 is worked out explicitly. (auth)

7765 RELATIONS FOR SUPERMATRICES IN HARTREE–FOCK–ROOTHAAN EQUATION. Matsuoka, O. (Univ. of Electro-Communications, Tokyo). Chem. Phys. Lett.; 11: No. 3, 290-1 (15 Oct 1971).

Relations are proved by which the double summations over symmetry subspecies appearing in J and K supermatrices of the Hartree–Fock–Roothaan equation are reduced to a single summation. (auth)

7766 SOLUTIONS OF THE EQUATIONS OF MOTION IN CLASSICAL AND QUANTUM THEORIES. Bialynicki-Birula, I. (Univ. of Pittsburgh. Univ., Warsaw). Contract AT(30-1)-3829. Ann. Phys. (N. Y.); 67: No. 1, 252-73(Sep 1971).

The relationship between the time dependence of quantum operators in the Heisenberg picture and the time dependence of the corresponding dynamical variables in the underlying classical theory is elucidated. This problem is studied in nonrelativistic particle mechanics and in field theory. It is shown how the operator solutions of the quantum equations of motion are related to the corresponding solutions of the classical equations of motion. An explicit formula is given that expresses quantum operators in the Heisenberg picture in terms of their classical counterparts. This formula is particularly useful in the study of the classical limit of the quantum theory. The dependence on ħ of the matrix elements of the coordinate operators and the field operators is explicitly given; thus, study of the quantum corrections to the classical theory in all orders is possible. Coherent states of the quantum system play an essential role in the formalism. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 7826.

7767 (NP-19122) ANNUAL REPORT, 1969: DEPARTMENT OF COSMIC HIGH ENERGY PHYSICS; DEPARTMENT OF ELEMENTARY PARTICLE PHYSICS; DEPARTMENT OF NUCLEAR PHYSICS. (Lund Univ. (Sweden). Lund Inst. of Tech. (Sweden)). Jan 1970. 131p. Dep. NTIS (U. S. Sales Only).

This annual report reviews the research carried out at the Departments of Cosmic High Energy Physics, Elementary Particle Physics and Nuclear Physics of the University of Lund and the Lund Institute of Technology. The connections of these departments are strong with integrated research and education. They are housed in a common building, have common electronic and mechanical workshops and a common computer station. The equipment is dominated by three accelerators: a 1.2-GeV electron synchrotron, a 3-MeV Van de Graaff generator and a 0.4-MeV neutron generator. The three departments are integrated parts of a center of physics to which departments of atomic physics, electronics, mathematical physics, solid state physics and theoretical physics belong. The research of these latter departments is not reviewed. A list of publications is included. (auth) (Sweden)

7768 (UCLA-10-P-17-X-1) [RESEARCH IN HIGH ENERGY PHYSICS.] Progress Report, 1955-1971. Richardson, J. R. (California Univ., Los Angeles). Contract AT(11-1)-Gen-10. 58p. Dep. NTIS.

A summary of research in high-energy physics covers K_2^0 interactions and decay, $\pi + e$ scattering, $\eta^1 \rightarrow \pi^+ + \pi^- + \gamma$ decay, and K + N interactions. A list of publications is included. (J.F.P.)

7769 PROCEEDINGS OF THE VI INTERAMERICAN SEMINAR ON COSMIC RAYS, LA PAZ, BOLIVIA, 19-24 JULY 1970. VOLUME III. Cuaderno No. 40. La Paz, Bolivia; Universidad Mayor de San Andres (1970). 309p. (In Spanish and English). (CONF-700708-(Vol.3)).

The conference included 19 papers one of which was abstracted previously in NSA (25: 9635). Separate abstracts were prepared for 18 papers. (J.F.P.)

For abstracts of individual papers see: 7783, 7784, 7804-7807, 7824, 7843, 7844, 7886, 7921-7925, and 7997-7999.

Electromagnetic

Refer also to abstracts 7618 and 8139.

7770 (CONF-710637-1) PHOTOPRODUCTION OF VECTOR MESONS (EXPERIMENTAL). Soeding, P. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct 1971. 74p. (IC-71/134). Dep. NTIS (U. S. Sales Only).

From Seminar on electromagnetic interactions; Trieste, Italy (21 Jun 1971).

In this review methods of polarizing photons, the polarization properties of ρ^0, ω, and ϕ photoproduction, cross sections for vector meson photoproduction on protons and the implications for the vector dominance model, photoproduction on deuterons and complex nuclei allowing tests of vector dominance, photoproduction phases, and the photoproduction of heavy mesons are covered. Emphasis is given to newer and more important experimental results. (J.F.P.)

7771 (DESY-71/50) PHOTOPRODUCTION II: COMPTON SCATTERING, VECTOR MESON PRODUCTION, AND OTHER PHOTON INDUCED REACTIONS. Wolf, Guenter (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Sep 1971. 107p. (CONF-710816-3). Dep. NTIS (U. S. Sales Only).

From International symposium on electron and photon interactions at high energies; Ithaca, N. Y. (23 Aug 1971).

Recent experimental results on photoproduction of nucleons are reviewed. Total γN cross sections, Compton scattering, vector meson production, and evidence for other resonance channels are discussed. (J.F.P.)

7772 (DESY-71/51) PROTON COMPTON SCATTERING BETWEEN 2.2 AND 7 GeV. Buschhorn, G.; Criegee, L.; Franke, G.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg (West Germany). Hamburg Univ. (West Germany). II. Institut fuer Experimentalphysik). Sep 1971. 14p. Dep. NTIS (U. S. Sales Only).

Proton Compton scattering was measured in a coincidence experiment at photon energies between 2.2 and 7 GeV and four-momentum transfers t between -0.06 and -0.85 $(GeV/c)^2$. For $|t| \leq 0.4$ $(GeV/c)^2$ fits of the form $d\sigma/dt = A \cdot \exp(Bt)$ yield forward cross sections A in good agreement with the values calculated from the total hadronic γp cross section via the optical theorem and the forward dispersion relation. The slopes B do not show a significant energy dependence, the mean value being 5.7 ± 0.4 $(GeV/c)^{-2}$. The cross section is substantially larger than predicted by the vector meson dominance model. (auth)

7773 (DESY-71/52) COMPTON SCATTERING OF 3.5 GeV POLARIZED PHOTONS ON PROTONS. Buschhorn, G.; Criegee, L.; Franke, G.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg (West Germany). Hamburg Univ. (West Germany). II. Institut fuer Experimentalphysik). Sep 1971. 9p. Dep. NTIS (U. S. Sales Only).

Elastic scattering of linearly polarized photons on protons was measured between 3.2 and 3.7 GeV for four-momentum transfers ranging from -0.1 to -0.7 $(GeV/c)^2$. The observed cross section asymmetry in this range is consistent with zero within ± 0.05. (auth)

7774 (DESY-71/56) ELECTROPRODUCTION OF ρ^0-MESONS ON PROTONS. Driver, C.; Heinloth, K.; Hoehne, K.; Hofmann, G.; Janta, F.; Karow, P.; Schmidt, D.; Specht, G.; Rathje, J. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct 1971. 39p. Dep. NTIS (U. S. Sales Only).

The electroproduction of transversely polarized ρ^0-mesons on protons was measured detecting the scattered electron and the two decay π-mesons in sparkchamber spectrometers. The differential cross sections $d\sigma_u/dt$ and $d\sigma_u/d(t - t_{min})$ were determined as functions both of W, q^2 and t and W, q^2 and $t - t_{min}$ in the following kinematical region: $2.60 \leq W \leq 2.95$ GeV, $-0.12 \geq q^2 \geq -0.40$ GeV^2/c^2, and $t_{min} \geq t \geq -0.15$ GeV^2/c^2. (auth)

7775 (DESY-71/61) INELASTIC ELECTRON PROTON SCATTERING AT $q^2 < 1$ $(GeV/c)^2$ AS A TEST OF FINITE ENERGY SUM RULES. Moritz, J.; Schmidt, K. H.; Wegener, D.; Bleckwenn J.; Engels, E. Jr. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct 1971. 34p. Dep. NTIS (U. S. Sales Only).

The twofold differential cross section for electroproduction on protons was measured for an electron scattering angle of 12°. The kinematic region covered in this experiment was 0.3 $(GeV/c)^2 < q^2 < 1.0$ $(GeV/c)^2$ and $W < 2.9$ GeV. The Bloom-Gilman as well as the constant scattering angle sum rule of Rittenberg and Rubinstein were tested and confirmed within the error limits of 5 to 15%. (auth)

7776 (LAL-1256) RESULTS OF THE ORSAY STORAGE RING A.C.O. Lefrancois, J. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Nov 1971. 39p. (CONF-710816-2). Dep. NTIS (U. S. Sales Only).

From International symposium on electron and photon interactions; Ithaca, N. Y. (23 Aug 1971).

The $e^+ + e^-$ interactions were studied in the ω^0 and ϕ^0 regions and at 990 MeV. Various branching ratios for the vector mesons are found. The $\pi^+\pi^-\pi^0$ decay mode was used to calculate the ω^0 width and production cross section. The ϕ^0 width and production cross section are also found. The integrated luminosity and cross section was found for the events $e^+ + e^- \rightarrow \pi^+ + \pi^- + 2\pi^0$ at 990 MeV. Also an experiment was performed on the $e^+ + e^- \rightarrow \mu^+ + \mu^-$ interaction in the ϕ region. The cross section for the interaction was found, and a branching ratio for $\phi \rightarrow e^+ + e^-$ decay was determined. Evidence was found for hadronic vacuum polarization with a confidence level above 95%. (J.F.P.)

7777 PHOTOPRODUCTION OF ETA MESONS FROM HYDROGEN. Dewire, J. (Cornell Univ., Ithaca, N. Y.); Gittelman, B.; Loe, R.; Loh, E. C. (and others). Phys. Lett.; 37B: No. 3, 326-8(29 Nov 1971).

The differential cross section for eta photoproductions was measured for incident photon energies of 4 and 8 GeV and momentum transfers $-t = 0.3$ to 0.8 $(GeV/c)^2$. (auth)

7778 COINCIDENCE MEASUREMENT OF BACKWARD π^0 ELECTROPRODUCTION. Brown, C. N.; Canizares, C. R.; Cooper, W. E.; (and others) (Harvard Univ., Cambridge, Mass.). Contract AT(30-1)-2752. Phys. Rev. Lett.; 27: No. 23, 1611-14(6 Dec 1971).

The reaction $e^- + p \rightarrow e^- + p + \pi^0$ was studied by detecting the final electron and proton in coincidence. The data cover the region of virtual photon mass squared from −0.19 to −1.4 GeV^2, and virtual photoproduction center-of-mass energy and angle from 1.84 to 2.50 GeV and 0° to 35°, respectively. (auth)

7779 COINCIDENCE π^0 ELECTROPRODUCTION EXPERIMENTS IN THE FIRST RESONANCE REGION AT MOMENTUM TRANSFERS OF 0.3, 0.45, 0.60, 0.76 $(GeV/c)^2$. Siddle, R. (Univ. of Manchester, Eng.); Dickinson, B.; Ibbotson, M.; (and others). Nucl. Phys.; B35: No. 1, 93-119(1971).

The reaction $e^- + p \rightarrow e^- + p + \pi^0$ was studied in the region of the first pion nucleon resonance. Four sets of data were analyzed at nominal values of the squared four-momentum transfer to the pion nucleon system, k^2, of 0.3, 0.45, 0.6 and 0.76 $(GeV/c)^2$. Results are presented on the variation with k^2 of the multipole amplitudes M_{1+}, E_{1+}, S_{1+} which contribute to the resonant partial wave, and also the behavior of E_{0+}, S_{0+} and M_{1-} contributing to the S and P-wave background is discussed. (auth)

7780 INCLUSIVE REACTION $\gamma + p \rightarrow \pi^- +$ ANYTHING IN THE PROTON FRAGMENTATION REGION. Swanson, W. P.; Davier, M.; Derado, I.; (and others) (Stanford Univ., Calif.). Phys. Rev. Lett.; 27: No. 21, 1472-5(22 Nov 1971).

The inclusive reaction $\gamma + p \rightarrow \pi^- +$ anything is studied in the energy range $E_\gamma = 5.5$ to 15 GeV. Experimental data on the differential cross section $\partial^2\sigma/\partial P_L\, \partial P_T^2$ in the target fragmentation region are qualitatively similar in shape in different energy intervals, but the magnitude shows a significant decrease with E_γ in this energy range. (auth)

7781 ACCURACY OF MEASUREMENTS OF CHARGED PARTICLE MOMENTA IN LARGE-GAP SPARK COUNTERS. Alikhanyan, A. I.; Asatiani, T. L.; Avakyan, K. M.; (and others) (Inst. of Physics, Erevan). Zh. Eksp. Teor. Fiz.; 61: No. 4, 1273-5(Oct 1971). (In Russian).

Results are presented of an investigation of the accuracy of measurements of charged particle momenta in a large-gap spark counter located in a magnetic field, a momentum calibrated π^- meson beam being employed. (auth)

7782 TEST OF QUANTUM ELECTRODYNAMICS BY $e^+e^- \rightarrow \mu^+\mu^-$. Balakin, V. E.; Budker, G. I.; Kurdadze, L. M.; (and others) (Inst. of Nuclear Physics, Novosibirsk, USSR). Phys. Lett.; 37B: No. 4, 435-7(13 Dec 1971).

At 4 values of energy from 1020 up to 1340 MeV the cross section of electron-positron annihilation to a μ-meson pair was measured, the limit of validity of quantum electrodynamics $\Lambda >$ 3.1 GeV was obtained. (auth)

7783 ANALYSIS OF BRISTOL–BOMBAIM DATA ON NUCLEAR INTERACTION PRODUCED BY PRIMARY COSMIC RADIATION OF $\Sigma E\gamma$ 1 TeV. Lattes, C. M. G.; Mantovani, M. (Univ. Campinas, Sao Paulo, Brazil). pp 623-34 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. III. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708–(Vol.3).

An analysis was made for electromagnetic cascades due to gamma-ray families produced by primary nucleons interacting with a graphite layer. The existence of intermediate states which decay isotropically in their rest reference system is assumed. The structure of these cascades is discussed. (J.F.P.)

7784 OBSERVATIONS ON SHOWERS PRODUCED AT 70 mwe UNDERGROUND. Dardo, M. (Univ., Turin. CNR, Turin); Navarra, G.; Penengo, P.; Sitte, K. pp 740-56 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. III. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays: La Paz, Bolivia (19 Jul 1970). See CONF-700708–(Vol.3).

A study of pairs of penetrating particles traversing two telescopes, in which locally produced interactions could be identified and delays between crossings recorded, revealed the presence of a group of weakly ionizing particles. They arrive with typical delays of about 10 to 20 nsec, and initiate showers in the lead absorbers of the telescope with an interaction mean free path of 750 plus 200 or minus 150 g per sq cm. They could be quarks. But in this case a quark flux underground of at least 3.4 × 10 to the minus 8th power per sq cm must be assumed, in contradiction to other observations. Thus the identification must remain tentative. (auth)

7785 ELECTROMAGNETIC INTERACTIONS OF HIGH-ENERGY MUONS. Allkofer, O. C.; Grupen, C. (Univ., Kiel). pp 1005-18 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. IV. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708–(Vol.4).

The electromagnetic interactions of muons in the energy range up to 1.0 TeV were investigated by a spark chamber calorimeter in connection with the Kiel spectrograph. It was aimed to investigate the different kinds of electromagnetic processes (knock-on-, direct pair-, bremsstrahlung- and multiple pions production) in the range of energy transfer from 0.2 up to 100 GeV. The production of pions is in reasonable agreement with the theoretical prediction of Daiyasu et al. The bremsstrahlung production is well described by the theory of Christy and Kusaka. However, it was found out that Bhabha's theory of the knock-on production yields too low values, for the cross section for the knock-on process, while the theory of Murota for the direct production of electron pairs by muons overestimates the corresponding cross section. (auth) (IAA)

Weak

7786 (SLAC-Trans–138) INTERACTION OF HIGH-ENERGY MUONS WITH NUCLEONS AND NUCLEI. Ermolov, P. F.; Sulyaev, R. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated for Stanford Linear Accelerator Center, Calif., from report IFVE-SPK–70-106. 20p. Dep. NTIS.

A proposal for a survey muon experiment to be performed on a beam of 30-GeV negative muons with the aid of a 2-m propane bubble chamber is presented. A possible way of performing the experiment is given, the main processes to be recorded are discussed and their yields are estimated. (auth)

7787 INDIRECT INTERFERENCE OF COSMIC-MUONS WITH LOW BACKGROUND COINCIDENCE EXPERIMENTS. Avignone III, F. T.; Darden III, C. W. (Univ of South Carolina, Columbia). Nucl. Instrum. Methods; 97: No. 2, 343-5(1971).

An experimental study has been made of the feasibility of detecting inverse beta decay reactions by a direct triple coincidence technique. It was found that (89 ± 13)% of the interfering background occurs less than 0.2 μs after the entrance of a cosmic-muon into the shielded region containing the target and detectors. The background may be caused by γ-ray cascades resulting from muon-nuclear reactions in the shielding material. (auth)

7788 MEASUREMENT OF THE $K_S^0 \rightarrow 2\pi$ DECAY BRANCHING RATIO. Baltay, C.; Bridgewater, A.; Cooper, W. A.; (and others) (Columbia Univ., N. Y.). Phys. Rev. Lett; 27: No. 24, 1678-81(13 Dec 1971).

The branching ratio $(K_S^0 \rightarrow \pi^+\pi^-)/(K_S^0 \rightarrow \pi^0\pi^0)$ was measured to be 2.22 ± 0.095; a total of ~32,000 $\overline{K}^0$'s produced by K^- charge exchange was utilized. (auth)

Strong (Baryon-Induced)

Refer also to abstracts 7601 and 8134.

7789 EXPERIMENTS AT THE ISR. CERN Cour.; 11: No. 9, 239-42(Sep 1971).

The present and planned experimental program at the CERN Intersecting Storage Rings is outlined. (W.H.K.)

7790 FOUR AND FIVE PION PRODUCTION IN $\bar{p}p$ NON-ANNIHILATION REACTIONS AT 6.94 GeV/c. Alexander, G.; Bar-Nir, I.; Dagan, S.; (and others) (Tel-Aviv Univ., Israel). Nucl. Phys.; B35: No. 1, 45-60(1971).

The four and five pion production in $\bar{p}p$ non-annihilation reactions was studied at 6.94 GeV/c incident momentum. Cross sections were determined for the different channels. The role of resonance production in these reactions was investigated, and copious Δ (1236) and $\overline{\Delta}$ (1236) production were found. Angular and momentum distributions for the outgoing particles are given and compared to the analogous reactions in pp collisions at the same energy. Various features of the data are compared to the predictions of some multiperipheral models. (auth)

7791 HELICITY CONSERVATION FOR LOW MASS $p\pi^+\pi^-$ SYSTEMS PRODUCED IN 16 GeV/cpp INTERACTIONS. Rushbrooke, J. G. (Cavendish Lab., Cambridge, Eng.); Williams, J. R.; Barford, N. C.; Losty, M. J. Nucl. Phys.; B35: No. 1, 1-12(1971).

It is shown from a study of 16 GeV/cpp interactions that helicity cannot in general be conserved in the s-channel for $p\pi^+\pi^-$ systems produced diffractively and with spin-change $\Delta J \geq 1$. Above a mass of about 1.6 GeV our results are consistent with t-channel helicity conservation. (auth)

7792 LARGE-ANGLE PROTON–PROTON ELASTIC SCATTERING AT INTERMEDIATE MOMENTA. Kammerud, R. C.; Brabson, B. B.; Crittenden, R. R.; (and others) (Indiana Univ., Bloomington). Phys. Rev., D; 4: No. 5, 1309-24(1 Sep 1971).

Differential cross sections were measured for large-angle p−p elastic scattering at intermediate momenta in an experiment performed at the Argonne National Laboratory Zero Gradient Synchrotron. A wire-spark-chamber detection system was employed. The results are reported at 13 momenta between 1.5 and 5.5 GeV/c, and cover the angular region $30 \leq \theta_{c.m.} \leq 90°$. The statistical accuracy of the data, presented in 2° bins in $\theta_{c.m.}$, is typically ±4%. The data suggest slope changes in the fixed-$\theta_{c.m.}$ cross sections near $-t = 0.8$ and $3(\text{GeV/c})^2$. The results of attempts to interpret the data in terms of optical models, the statistical model, the Regge-pole model, and a diffractive model are presented. A Regge calculation which predicts the masses at which dibaryon resonances might be expected to occur is outlined. (auth)

7793 PROTON–DEUTERON ELASTIC SCATTERING AT 1.0 GeV/c. Booth, N. E.; Dolnick, C.; Esterling, R. J.; (and others) (Univ. of Chicago). Phys. Rev., D; 4: No. 5, 1261-7 (1 Sep 1971).

The differential cross section and polarization in p–d elastic scattering were measured at an incident laboratory momentum of 0.99 GeV/c (kinetic energy 425 MeV) over most of the angular range. Elastic p–d scattering events from a CD_2 target were selected by angular correlation, coplanarity, and time of flight. A significant feature of the results is the large positive polarization at backward scattering angles. (auth)

7794 OBSERVATION OF $\bar{p}p \rightarrow 2\pi^0$ AT REST: EVIDENCE CONCERNING s-STATE ANNIHILATION. Devons, S. (Columbia Univ., New York); Kozlowski, T.; Nemethy, P.; (and others). Phys. Rev. Lett.; 27: No. 23, 1614–17(6 Dec 1971).

The annihilation mode $\bar{p}p \rightarrow 2\pi^0$ for antiprotons stopping in liquid hydrogen was identified at a rate that is 0.15 (±20%) times that reported for $\bar{p}p \rightarrow \pi^+\pi^-$. This indicates that about 40% of all annihilations into 2π take place from odd-orbital atomic $\bar{p}p$ states, in contrast to the usual assumption that annihilation from the s state predominates. (auth)

7795 REACTION $\bar{p}p \rightarrow \bar{K}K\pi\pi\pi$ at 1.6 TO 2.2 GeV/c. Chapman, J. W.; Green, R.; Lys, J.; (and others) (Univ. of Michigan, Ann Arbor). Phys. Rev., D; 4: No. 5, 1275-84(1 Sep 1971).

Antiproton-proton annihilations into final states $K_1^0K_1^0\pi^+\pi^-\pi^0$, $K_1^0K^\pm\pi^\mp\pi^+\pi^-$, $K_1^0K_2^0\pi^+\pi^-m\pi^0$ ($m \geq 1$), and $K^+K^-\pi^+\pi^-\pi^0$ were studied in a bubble-chamber experiment at six incident momenta in the range 1.6 to 2.2 GeV/c, corresponding to a total center-of-mass energy range 2290 to 2500 MeV. The explicit use of charge-conjugation symmetry allowed the study of the $K^+K^-\pi^+\pi^-\pi^0$ final state with very few ambiguities in our sample of events. A search for direct-channel resonances revealed a ~3-standard-deviation enhancement in the $K^+K^-\omega$ channel at 2350 MeV, but no corresponding enhancement appears in the $K_1^0K_1^0\omega$ or $K_1^0K_2^0\omega$ channels. No evidence was found for a previously reported $K^*K\pi\pi$ resonant state near 2360 MeV. (auth)

7796 EVIDENCE FOR A NEUTRAL BOSON OF MASS 953 MeV AND NARROW WIDTH. Maglich, B. (Rutgers–The State Univ., New Brunswick, N. J.); Oostens, J.; Silverman, M.; (and others). Phys. Rev. Lett.; 27: No. 21, 1479-81(22 Nov 1971).

A 20-standard deviation peak was observed at a mass of $953.4^{+1}_{-2.5}$ MeV and with a physical width $\Gamma < 15$ MeV; it was produced with $(d\sigma/d\Omega)_{c.m.,60°} = 2 \times 10^{-35}$ cm^2/sr in the reaction $p + d \rightarrow {}^3He$ + missing mass. The incident proton energy was 3 GeV, and the proton-to-meson and proton-to-^{3}He transfers were $t = -1.74$ and $u = -4$ $(\text{BeV/c})^2$, respectively. The $\eta_0(958)$, $\delta^0(963)$, and φ^0 (1019) were not observed and the $\rho^0(765)$ was not apparent in our data. (auth)

7797 INCLUSIVE $\bar{p} + p \rightarrow \pi$ + ANYTHING AT 2.32 GeV/c. Hoang, T. F. (Argonne National Lab., Ill.); Rhines D.; Cooper, W. A. Phys. Rev. Lett; 27: No. 24, 1681-5(13 Dec 1971).

An analysis of the double differential cross section of the inclusive $\bar{p}p$ interaction is presented. A comparison of various forms of the distribution function is made. The best fit is obtained using a Bose-type distribution with two parameters and ordinary phase space for the cross section. (auth)

7798 LONGITUDINAL DEVELOPMENT OF NUCLEAR–ELECTROMAGNETIC CASCADES AT ENERGIES AROUND 10^{12}eV. Gillespie, Charles Richard. Baton Rouge, La.; Louisiana State Univ. and A and M Coll. (1971). 97p. University Microfilms Order No. 71-29,366.

Thesis.

An experiment was performed in which the longitudinal development of nuclear-electromagnetic cascades resulting from 71 hadron-nucleus interactions was measured. The hadrons had energies greater than 0.5 TeV and were incident on a glass-scintillator ionization spectrometer which was 11 interaction lengths deep. With this spectrometer the development of the nuclear-electromagnetic cascade was measured in terms of the ionization energy loss by the cascade in the spectrometer. A calibration technique was developed which allowed the ionization energy loss measurements to be expressed in energy units. The average energy of the single hadrons incident on the apparatus was 1 TeV. The integral energy spectrum of the hadrons was described by a power law with an exponent of 2.1 ± .3 in the energy interval from 0.5 TeV to 1.0 TeV. The average nuclear-electromagnetic cascade ionization energy loss for all incident hadrons was found and the results compared with corresponding three dimensional Monte Carlo nuclear-electromagnetic cascade calculations. By describing the decrease of the nuclear-electromagnetic cascade with an exponential decay, the effective average inelasticity of the hadron-nucleus interactions was indicated to be slightly greater than the value of 0.5 assumed in the Monte Carlo calculations for proton-glass interactions. (Diss. Abstr. Int., B)

7799 ABSENCE OF DISCRETE s-CHANNEL RESONANCES IN $\bar{p}p$ INTERACTIONS AT INTERMEDIATE ENERGIES. Fields, T. (Argonne National Lab., Ill.); Cooper, W. A.; Rhines, D. S.; Allison, W. W. M. Phys. Rev. Lett.; 27: No. 25, 1749-52 (20 Dec 1971).

New experimental results on ρ/ω interference and two-body cross sections in $\bar{p}p$ annihilation at 2.3 GeV/c are given. These are used, together with ρ/ω interference results from lower energies, to argue that the annihilation process is not mediated by discrete s-channel mesonic resonances in the mass range 2.1 to 2.6 GeV. (auth)

7800 SOME GROSS FEATURES OF SINGLE-PARTICLE SPECTRA AT ENERGIES ABOVE 10^4 GeV AND COMPARISONS WITH DATA AT 28.5 GeV. von Lindern, L. (Brookhaven National Lab., Upton, N. Y.); Panvini, R. S.; Hanlon, J.; Salant, E. O. Phys. Rev. Lett.; 27: No. 25, 1745-8(20 Dec 1971).

Single-particle spectra from multiparticle production in pp collisions at 28.5 GeV/c from bubble-chamber data are compared with cosmic-ray emulsion data above 10^4 GeV. The spectrum at high energies does not develop a plateau as expected from multiperipheral models, and the target-fragmentation cross section decreases, approximately as 1/lns. (auth)

7801 TRANSVERSE MOMENTUM DISTRIBUTION OF PHOTONS PRODUCED IN PROTON–PROTON COLLISIONS AT THE INTERSECTING STORAGE RINGS. Neuhofer, G.; Niebergall, F.; Penzias, J.; (and others) (CERN, Geneva). Phys. Lett.; 37B: No. 4, 438-40(13 Dec 1971).

The energy spectrum of γ-rays produced in proton-proton collisions at the CERN Intersecting Storage Rings (ISR) was measured at 90°. The spectrum is an exponential function of the transverse momentum. Its slope is found to be energy independent from 6.7 GeV to 53 GeV center of mass energy. It is shown that the same result holds for neutral pions. (auth)

7802 EXPERIMENTAL STUDY OF FOUR-PRONG EVENTS IN PROTON–PROTON INTERACTIONS AT 13.1 GeV/c. Le Guyader, J. (LPNHE, Paris); Sene, M.; Ginestet, J.; (and others). Nucl. Phys.; B35: No. 2, 573-91(1971).

Approximately 21,000 four-prong pp interactions at 13.1 GeV/c were studied using the CERN 2m hydrogen bubble chamber. The following reactions have been analyzed: $pp \rightarrow pp\pi^+\pi^-$, $pp \rightarrow pp\pi^+\pi^-\pi^0$, and $pp \rightarrow pn\pi^+\pi^+\pi^-$. The Δ-production is the dominant feature. The $p\pi\pi$ decay of the N*(1470) and N*(1690). The ρ is weakly produced in the three reactions. The η and ω are observed in the $\pi^+\pi^-\pi^0$ mass spectrum and the presence of a $p\omega$ isobar is discussed. Then the kinematical characteristics of the final particles are described. (auth)

7803 ANGULAR-MOMENTUM CUTS AND SCALING OF TOTAL CROSS SECTIONS AT HIGH ENERGIES. Curry, P.; Moffat, J. W. (Univ. of Toronto). Phys. Rev. Lett.; 27: No. 25, 1755-7(20 Dec 1971).

High-energy total cross sections for the $\pi^\pm p$, $K^\pm p$, $\bar{p}p$, and pp reactions are analyzed using a Regge-pole model combined with an odd-signature cut. It is found that the asymptotic cross sections, when plotted versus $\omega = s/2M_1M_2$, satisfy a scaling law within specified normalization constants. (auth)

7804 ALEPH PARTICLE. Fujimoto, Y.; Sugimoto, K. (Waseda Univ., Japan). pp 635-8 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. III. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708–(Vol.3).

A determination was made of whether the observation of successive nuclear interactions in emulsion chambers was consistent with the aleph-particle model. It was concluded that these observations were not in agreement with this model. (J.F.P.)

7805 PROPERTIES OF PROTON–PROTON INTERACTIONS BETWEEN 70 AND 600 GeV. Jones, L. W. (Univ. of Michigan, Ann Arbor); Bussian, A. E.; DeMeester, G. D.; (and others). pp 651-83 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. III. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.3).

A cosmic ray experiment at Echo Lake, Colorado, employing a 2000-liter liquid hydrogen target together with spark chambers and an ionization calorimeter has been used to study the interactions of protons with protons at energies above 70 GeV. Analyzed data have given quantitative results on the energy dependence of average charged-particle multiplicity, on the distributions of prong multiplicities and angles, and on the difference between reactions in hydrogen and in heavier target nuclei. The neutron-charged hadron flux ratio was studied and detailed characteristics of the ionization calorimeter were systematically analyzed. Finally, the first direct measurements of the nucleon-nucleon total inelastic cross section are reported. (auth)

7806 OBSERVATION OF HIGH-ENERGY NUCLEAR BURSTS AT CHACALTAYA. Murakami, K. (Univ. Mayor de San Andres, La Paz, Bolivia); MacKeown, K.; Yokoyama, C.; (and others). pp 695-705 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. III. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.3).

High-energy nucleonic cosmic ray particles ($E > 3 \times 10^{12}$ eV) without accompanying air shower were observed at Chacaltaya (5200 m.a. s.l.), Bolivia. These particles are most likely the surviving primary protons arriving at Chacaltaya without suffering any catastropic interaction in the atmosphere. The integral energy spectrum of these particles is represented by a power function with an exponent around -2.3 for energies in the range 10^{12} to 10^{14} eV, which is steeper than the energy spectrum of the total primary cosmic rays for the corresponding energy range. The recent data are presented, and the results discussed. (auth)

7807 BEHAVIOR OF INELASTIC NUCLEON-NUCLEUS CROSS SECTION FROM 10^2 TO 10^5 GeV. Yodh, G. B.; Wayland, J. R.; Pal, Yash (Univ. of Maryland, College Park). pp 706-22 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. III. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.3).

The analysis of results of recent cosmic ray measurements of inelastic cross sections of protons on carbon, primary proton spectra, and unaccompanied hadron spectra at different atmospheric depths are discussed. The unaccompanied hadron spectra at different depths in the atmosphere are compared to primary proton spectra, and a lower bound to proton-air inelastic cross section above 500 GeV is derived. (auth)

Strong (Meson-Induced)

7808 EXPERIMENTAL VERIFICATION OF QUARK MODEL PREDICTIONS FOR THE REACTION $K^+p \rightarrow K^{*0}N^{*++}$ AT 3 GeV/c. Zralek, M. (Jagellonian Univ., Krakow). Acta Phys. Pol.; A40: No. 4, 535-6(1971).

The quark model relations of class (c) are tested in the Donohue-Högaasen frame of vector meson and of isobar in the reaction $K^+p \rightarrow K^{*0}N^{*++}$. It is shown that in such a reference frame the agreement with the data of Abrams et al. is significantly improved. Some discrepancies persist, however, also in this reference frame. (auth)

7809 $\rho-\omega$ INTERFERENCE AND EXCHANGE DEGENERACY IN π^+p INTERACTIONS AT 5.45 GeV/c. Bloodworth, I. J.; Jackson, W. C.; Prentice, J. D.; Yoon, T. S. (Univ. of Toronto). Nucl. Phys.; B35: No. 1, 133-40(1971).

The reactions $\pi^+p \rightarrow \Delta^{++}\pi^+\pi^-$ and $\pi^+p \rightarrow \Delta^{++}\pi^+\pi^-\pi^0$ are used to study $\rho-\omega$ interference at 5.45 GeV/c. The fitted ρ mass from a $\rho-\omega$ interference fit is 788 MeV suggesting the possibility of a sum of different interference patterns. Hence the events are weighted by spin density matrix elements which tend to isolate particular exchanges. Results of a fit to these weighted events do not generally agree with the predictions of strong $\pi-B$ and $\rho-A_2$ exchange degeneracy. (auth)

7810 STRANGE-PARTICLE PRODUCTION FROM π^+p INTERACTIONS IN THE C. M. ENERGY RANGE 1820 TO 2090 MeV. Hanson, P.; Kalmus, G. E.; Louie, J. (Univ. of California, Berkeley). Phys. Rev., D; 4: No. 5, 1296-1309(1 Sep 1971).

Data at nine π^+ momenta are presented in the following three-body final states: $\Sigma^+K^+\pi^0$, $\Sigma^+K^0\pi^+$, $\Sigma^0K^+\pi^+$, $\Lambda K^+\pi^+$, $pK^+\bar{K}^0$. The data consist of cross sections, Dalitz plots, and angular distributions for the quasi-two-body final state $Y^{*+}(1385)K^+$. In the channel $Y^{*+}(1385)K^+$ the production and Y^* decay distributions are compared with the predictions of Stodolsky and Sakurai. (auth)

7811 STUDY OF THE REACTIONS $K^- + n \rightarrow \Sigma^\mp$ + MESONS AT 4.93 GeV/c. Dibianca, Frank A.; Einschlag, Michael B.; Endorf, Robert; (and others) (Carnegie-Mellon Univ., Pittsburgh). Nucl. Phys.; B35: No. 1, 13-44(1971).

Data on ten quasi-two-body reactions produced in K^-n interactions at 4.93 GeV/c are presented. Cross sections, four-momentum transfer distributions, and density matrix elements are discussed. Results of a search for inelastic decays of high mass Y^* hyperons are given. Precision measurements of the ϕ^0 mass and width are reported. Possible direct channel Y^* formation is investigated. (auth)

7812 DIFFRACTION DISSOCIATION AND PROCESSES INVOLVING CHARGE, STRANGENESS, AND EXOTIC EXCHANGES IN FOUR-BODY FINAL STATES OF K^-p REACTIONS AT 10 GeV/c. Beaupre, J. (Technische Hochschule, Aachen); Deutschmann, M.; Kirk, H.; (and others). Nucl. Phys.; B35: No. 1, 61-78(1971).

The reactions $K^-p \rightarrow K^-\pi^+\pi^-p(1)$, $K^-p \rightarrow \bar{K}^0\pi^-\pi^0p(2)$, $K^-p \rightarrow \bar{K}^0\pi^+\pi^-n(3)$ and $K^-p \rightarrow \pi^+\pi^-\pi^0\Lambda(4)$ all with final states of the type $M\pi\pi B$ are studied and compared using longitudinal phase space (LPS) techniques to separate configurations corresponding to specific production mechanisms. It is found that multiperipheral processes involving three, or two, exchanges do not give important contributions and that the four-body final states are mostly produced by peripheral processes with two particle-clusters in the intermediate state. Among these single exchange processes, pomeron (P) exchange leading to diffraction dissociation of the kaon or of the proton is dominant. Processes of charge exchange, $\Delta Q = 1$, which imply meson (M) exchange are more frequent than processes involving strangeness (S) exchange. Exotic (E) exchanges, $\Delta Q = 2$, may be compatible with zero. The hierarchy of exchanges is thus P > M > S > E. Similarly, for the slopes A of the differential cross sections $d\sigma/dt \propto e^{-At}$, $A(P) > A(M) > A(S) > A(E)$. Evidence is found for the validity of the Gribov-Morrison rule, resulting in suppression of pomeron-exchange in double dissociation channels. In the mass spectra of the different LPS sectors, the known resonances are clearly visible, with small background. Comparison of the cross sections for diffraction dissociation of the proton in $K^-p \rightarrow K^-(\pi^+\pi^-p)$ with $K^+p \rightarrow K^+(\pi^+\pi^-p)$ and $\pi^\pm p \rightarrow \pi^\pm(\pi^+\pi^-p)$ gives results consistent with factorization. (auth)

7813 $\Delta^{++}\rho^0$ AND $\Delta^{++}\omega^0$ FINAL STATES AT 5.45 GeV/c. Bloodworth, I. J.; Jackson, W. C.; Prentice, J. D.; Yoon, T. S. (Univ. of Toronto). Nucl. Phys.; B35: No. 1, 79-92(1971).

Results are reported on the $\Delta^{++}\rho^0$ and the $\Delta^{++}\omega^0$ final states obtained from a 4 event/μb exposure of the Argonne National Laboratory 30 inch hydrogen bubble chamber to a π^+ beam at 5.45 GeV/c. Data are presented on cross sections, differential cross sections, spin density matrix elements and differential cross sections weighted by density matrix elements. Certain features of the data relevant to various Regge models are noted and the data is compared to a π-B exchange degenerate Regge model due to Abrams and Maor. (auth)

7814 TEST ON THE SPIN-PARITY OF $K\pi\pi$ RESONANCE PRODUCED FROM 5-GeV/c Kp INTERACTIONS IN BUBBLE CHAMBER. Huq, S. S. (Univ. of Rajshahi, East Pakistan). J. Natur. Sci. Math.; 10: No. 2, 167-77(Oct 1970).

The reactions $K^+p \rightarrow K^+\pi^+\pi^-p$ were studied from a sample 180,000 measured four-body final state interaction with no seen missing neutral particles. This yielded 6347 uniquely fitted reaction of $K^+p \rightarrow K^+\pi^+\pi^-p$ produced with a total cross section of (1.8 ± 0.15) mb $K^+\pi^+\pi^-$ effective mass spectrum without any mass cuts for $K^*(892)$ and $N^*(1236)$ resonances showed the existence of two distinct peaks centered around 1320 and 1420 MeV/c^2 superimposed on a broad background known as $K^*(1320)$ and $K^*(1420)$ resonances. No evidence for structure in this broad $K\pi\pi$ enhancement around 1320 MeV/c^2 was found in this unselected mass plot in direct contrast to the claim of Bassompierree et al [Physics 67-25, 24-10(1969)] that there are three resonant states in this region. Polar angular distributions Θ of the normal to the $K\pi\pi$ decay plane were studied in different mass regions of $K\pi\pi$ spectrum, and in the 1320 MeV/c^2 region, this showed distinctly $\sin^2 \Theta$ type distributions consistent with the production of this resonance in spin parity state of $J^P = 1^+$. Azimuthal angular distributions were clearly flat in the same region thereby confirming that $K^*(1320)$ resonance was produced in $m = 0$ magnetic substrate with respect to the incident K^+ direction as Z-axis. (auth)

7815 STUDY OF ω EXCHANGE ISOLATED IN THE REACTIONS $\pi p \rightarrow \rho N$ AT 6 GeV/c. Crennell, David J.; Gordon, Howard A.; Ioffredo, Michael L.; Lai, Kwan-wu; Scarr, J. Michael (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett; 27: No. 24, 1674-7(13 Dec 1971).

Dips are observed at t~ -0.45 GeV^2 in the differential cross sections of the reactions $\pi^{\pm}p \rightarrow \rho^{\pm}p$, as well as a break at t~ -0.25 GeV^2 in the differential cross sections for $\pi^-p \rightarrow \rho^0n$, at 6 GeV/c. The I = 0 ω-exchange contribution in the t channel is isolated by calculating $R^2(t) = \frac{1}{2}[(d\sigma/dt)(\pi^-p \rightarrow \rho^-p) + (d\sigma/dt)(\pi^+p \rightarrow \rho^+p) - (d\sigma/dt)(\pi^-p \rightarrow \rho^0n)]$. The function $R^2(t)$ vanishes at t~ -0.45 GeV^2 and is well parametrized by a Bessel function of the first kind, $J_1^2(r\sqrt{-t})$, with r ~ 1 F. (auth)

7816 DETERMINATION OF THE ω^0 SPIN-DENSITY-MATRIX ELEMENTS IN THE REACTION $\pi^-p \rightarrow \omega^0n$. Holloway, L. E. (Univ. of Illinois, Urbana); Huld, B.; Jordan, M.; (and others). Phys. Rev. Lett; 27: No. 24, 1671-4(13 Dec 1971).

Measurements of the ω^0 spin-density matrix elements in the reaction $\pi^-p \rightarrow \omega^0n$ at incident momenta of 3.65, 4.5, and 5.5 GeV/c are reported. In the Gottfried–Jackson frame the data exhibit nonzero values of ρ_{00}, indicating the presence of unnatural-parity exchange, as well as a large value of $\rho_{11} + \rho_{1-1}$ that does not show a dip in the momentum transfer distribution. The unnatural-parity contribution decreases with respect to the natural-parity contribution as the momentum increases. (auth)

7817 ISOTROPIC BLACK-BODY BOSON PRODUCTION AND THE TEMPERATURE OF HADRONIC MATTER. Erwin, J.; Ko, W.; Lander, R. L.; Pellett, D. E.; Yager, P. M. (Univ. of California, Davis). Contract AT(04-3)-34. Phys. Rev. Lett.; 27: No. 22, 1534-7(29 Nov 1971).

Inclusive π^+, π^-, and K^0 production from 11.8-GeV/c K^+p is isotropic in the center-of-mass system and obeys a Bose–Einstein distribution over a limited energy range. The values of the parameter kT are observed to be consistent with the pion mass. (auth)

7818 LIMITING PROPERTIES IN INCLUSIVE π^+p REACTIONS AT 8 AND 16 GeV/c WITH EXOTIC AND NON-EXOTIC PARTICLE COMBINATIONS. Beaupre, J. V. (Technische Hochschule, Aachen); Deutschmann, M.; Kirk, H.; (and others). Phys. Lett.; 37B: No. 4, 432-4(13 Dec 1971).

The distributions in the Feynman variable x for the pions produced in the inclusive reactions (1) $\pi^+p \rightarrow \pi^-$ + anything and (2) $\pi^+p \rightarrow \pi^+$ + anything are compared at 8 and 16 GeV/c. The distributions are similar in first approximation, but second order differences are observed. In particular, at $x \approx 0$ the distributions for π^+ overlap at the two energies for π^- are different, and at $x \approx -1$ they are similar for π^- but not for π^+. Comparison of the longitudinal momentum spectra in the lab. (target) system gives results consistent with limiting fragmentation for reaction (1), but not for reaction (2). Since the combination $(ab\bar{c})$ is $(\pi^+p\pi^+)$, exotic, for reaction (1) and $(\pi^+p\pi^-)$, non exotic, for reaction (2), these results are consistent with the suggestion of Chan et al. that when $(ab\bar{c})$ is exotic, limiting fragmentation may set in already at moderate (accelerator) energies. (auth)

7819 FINAL STATES WITH THREE CHARGED PARTICLES AND A VISIBLE $\bar{K}^0$ FROM K^-d INTERACTIONS AT 4.5 GeV/c. Yen, W. L. (Indiana Univ., Indianapolis. Purdue Univ., Indianapolis); Ammann, A. C.; Carmony, D. D. ; (and others). Nucl. Phys.; B35: No. 2, 317-31(1971).

A study of the interactions of 4.48 GeV/c K^- mesons on neutrons is reported. The 372,000 picture exposure was taken in the Argonne National Laboratory 30 inch deuterium-filled bubble chamber, $\bar{K}^0$ final states from the three-or four-prong-plus-vee topologies are discussed. The final states investigated include (1) $K^-n \rightarrow p\pi^-\pi^-K^0$, (2) $K^-n \rightarrow p\pi^-\pi^-\bar{K}^0\pi^0$, (3) $K^-n \rightarrow \pi^+\pi^-\pi^-\bar{K}^0n$. These reactions are dominated by $K^*(890)$ and $\Delta(1236)$ production and the quasi-two-body reaction $K^-n \rightarrow K^{*-}\Delta^0$ was studied. A search for exotic resonances found no evidence for their production. A Reggeized multiperipheral model of Plahte and Roberts was applied to reactions (1) and (3). Good agreement with data is obtained for distributions in (i) cos θ^*, (ii) effective mass. The model also gives the correct energy dependence between 3 and 4.5 GeV/c. (auth)

7820 K^- MESON ABSORPTION IN NEON. Moulder, J. W. (Univ. of Tennessee, Knoxville); Garrett, N. E.; Tucker, L. M.; (and others). Nucl. Phys.; B35: No. 2, 332-50(1971).

From 2267 measured events in a hydrogen-neon mixture 1549 interactions of stopping K^- mesons with neon were isolated. Results are presented on momentum spectra, hyperfragment production, $\Sigma - \Lambda$ conversion, non-mesic absorption, relative neutron-proton interaction rates and $\Sigma - \pi$ angular correlation. (auth)

7821 MEASUREMENT OF THE DIFFERENTIAL CROSS SECTION FOR ELASTIC PION–HELIUM SCATTERING AT 7.76 GeV/c. Ekeloef, T. (Univ. of Uppsala); Hoeistad, B.; Aesberg, A.; (and others). Nucl. Phys.; B35: No. 2, 493-502(1971).

Results are presented for the region of squared four-momentum transfers between -0.05 and -0.5 (GeV/c)^2. The directions of the scattered pions and α particles were measured with spark chambers and the momentum of the alphas was obtained from pulse-height and time-of-flight measurements. The results are compared with calculations from the Glauber theory, showing good agreement over the whole momentum-transfer range including the interference-dip region. (auth)

7822 HELICITY CONSERVATION FOR $K^-p \rightarrow Q^-p$ AT 8.25 GeV/c. Buschbeck, B. (Inst. fuer Hochenergiephysik, Vienna); Froehlich, A.; Markytan, M.; (and others). Nucl. Phys.; B35: No. 2, 511-16(1971).

The reaction $K^-p \rightarrow Q^-p \rightarrow p(K^-\pi^+\pi^-)$ at 8.25 GeV/c favors t-channel helicity conservation over s-channel helicity conservation. This is shown by comparing the Q density matrix elements with the predictions of the above two hypotheses as functions of the crossing angle. (auth)

7823 COHERENT PRODUCTION OF $K^{*-}(890)$ BY K^- AT 10 AND 12.7 GeV/c ON $A \approx 20$ NUCLEI. Daugeras, B. (Laboratoire de l'Accelerateur Lineaire, Orsay, France); Fournier, D.; Hennessy, J.; (and others). Phys. Rev. Lett.; 27: No. 25, 1752-5(20 Dec 1971).

Coherent $K^{*-}(890)$ production by K^- of 10.0 (12.7) GeV/c on $A \approx 20$ nuclei is observed with $\sigma_A = 150 \pm 50$ (131 ± 35) μb/nucleus. The K^* alignment, t′ distribution and cross section are consistent with production via isoscalar, natural-parity exchange. (auth)

7824 SOME PROBLEMS ON INELASTIC INTERACTIONS OF PARTICLES AT VERY HIGH ENERGIES. Dobrotin, N. A. (Inst. of Physics, Moscow). pp 537-63 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. III. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708–(Vol.3).

A review is given of some selected topics on inelastic interactions at very high energies. The comparison of the characteristics of pion- and nucleon-induced interactions at high energies, the classification of inelastic coherent, peripheral, and central interactions, the mechanism of inelastic interactions with the generation of fireballs, isobars, and resonances, and a comparison of nucleon–nucleon and nucleon–nucleus interactions are covered. (J.F.P.)

Particle Interactions and Properties (Theoretical)

General

7825 (COO–1764-119) MULTIPARTICLE PRODUCTION PROCESSES. Gasiorowicz, S. (Minnesota Univ., Minneapolis). 1971. Contract AT(11-1)-1764. 119p. Dep. NTIS.

Some aspects of the present theory of multiparticle reactions are presented in a model-independent manner. The review includes the kinematics, multiperipheral theory, limiting distributions, the one-particle distribution in inclusive processes, diffractive processes, the extension of Reggeism to inclusive reactions, and a discussion of the new phenomenology from the identification of inclusive cross sections with discontinuities in three-particle scattering matrix elements. (J.F.P.)

7826 (NP–18954) [FUNDAMENTAL RESEARCH ON MATTER AND NUCLEAR RESEARCH]. Annual Report, 1969. (Stichting voor Fundamenteel Onderzoek der Materie, Utrecht. Stichting Instituut voor Kernphysisch Onderzoek, Amsterdam (Netherlands)). 145p. (In Dutch). Dep. NTIS (U. S. Sales Only).

Research in the areas of high energy physics, nuclear physics, atomic physics, solid state, metallurgy, molecular physics, and thermonuclear reactions is reviewed and summarized. Lists of publications issued are included. (C.E.S.)

7827 (NYO–2262-TA-254) CONSTRUCTION OF MULTIPERIPHERAL DYNAMICAL EQUATIONS AND INCLUSIVE SUM RULES. Tan, Chung-I (Brown Univ., Providence, R. I. Dept. of Physics). [1971]. 12p. Dep. NTIS.

Multiperipheral-like integral equations are derived from inclusive sum rules by making direct approximations on inclusive cross sections. As a result, the physical basis of multiperipheral dynamics is clarified. Furthermore, the Regge behavior for exclusive processes and the scaling property of inclusive cross sections can be considered as consequences of the dynamical approximations. (auth)

7828 EIKONAL REPRESENTATION FOR SCATTERING AMPLITUDES OF DIRAC PARTICLES ON ARBITRARY POTENTIAL. Pervushin, V. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 9: No. 2, 264-72(Nov 1971). (In Russian).

By the functional integration method the deduction of the eikonal representation for scattering amplitude of the Dirac particle on an arbitrary potential is performed. The method generalizing the usual operation of taking the square of the Dirac equation is proposed for obtaining the functional integral representation of the amplitude. (auth)

7829 A NEW THEORY OF ELEMENTARY MATTER. PART I. PHILOSOPHICAL APPROACH AND GENERAL IMPLICATIONS. Sachs, Mendel (State Univ. of New York, Buffalo). Int. J. Theor. Phys.; 4: No. 6, 433-51(Oct 1971).

An exposition of the philosophical approach and its general implications of a new theory of elementary matter is presented. The theory is based on three axioms: the principle of general relativity, a generalized Mach principle, and a correspondence principle. The approach is basically a deterministic, relativistic field theory which fully incorporates the idea that any realistic physical system is in fact a closed system, without separable parts. It is shown that the most primitive mathematical expression of this theory, following as a necessary consequence of its axioms, is in terms of a set of coupled nonlinear spinor field equations. Nevertheless, the exact formalism is constructed to asymptotically approach the quantum mechanical formalism for a many-particle system, in the limit of sufficiently small energy-momentum transfer among the components of the considered closed system. Thus, all of the mathematical predictions of nonrelativistic quantum mechanics are contained in this theory, as a mathematical approximation. However, predictions follow from the exact form of this theory (where energy-momentum transfer can be arbitrarily large) that are not contained in the quantum theory. (UK)

7830 RAPID SCALING AND INCLUSIVE SUM RULES. Caneschi, L. (CERN, Geneva). Phys. Lett.; 37B: No. 3, 288-91(29 Nov 1971).

The influence of s channel quantum numbers on inclusive distributions is investigated. The way chosen by nature to enforce charge conservation is proposed as a test for production models. (auth)

7831 DUALITY CONSTRAINTS IN INCLUSIVE REACTIONS. Einhorn, M. B. (Univ. of California, Berkeley); Green, M. B.; Virasoro, M. A. Phys. Lett.; 37B: No. 3, 292-3(29 Nov 1971).

A possible implementation of the Harari–Freund conjecture on a dual model is shown to lead to the vanishing of the pomeron–pomeron–reggeon coupling and a unique criterion for the absence of nonscaling (secondary) terms in inclusive reactions. (auth)

7832 ASYMPTOTIC BEHAVIOR OF CROSS SECTIONS AND MASSLESS PARTICLES EXCHANGE. Dolgov, A. D.; Okun, L. B.; Zakharov, V. I. (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Lett.; 37B: No. 3, 298-9(29 Nov 1971).

Upper bounds on possible asymptotic growth of the cross section are obtained in the case of neutrino pair exchange. The dispersion relations in s at fixed $t \leq 0$ are assumed to be valid. The bounds are then derived from the requirement of finiteness of the amplitude at $t = 0$ and finite s and from the comparison of the threshold singularities due to zero-mass exchange in the t-channel and the so-called shrinkage singularities due to shrinkage of diffraction peak at ultra high energy. (auth)

7833 IMPULSE, MULTIPLE-SCATTERING, GLAUBER, AND NO-RECOIL APPROXIMATIONS. Remler, E. A. (Coll. of William and Mary, Williamsburg, Va.). Ann. Phys. (N. Y.); 67: No. 1, 114-23(Sep 1971).

It is pointed out that the usual forms of the impulse approximation and multiple scattering equations are deficient in a no-recoil limit. This is the limit in which the scatterer suffers negligible recoil during intermediate collisions leading to a given final state. A version of the impulse approximation and multiple scattering equation appropriate to the no-recoil limit and a precise definition and expansion about the limit is proposed. The no-recoil approximation includes the Glauber approximation as a limiting case, and the relation between the two is discussed. (auth)

7834 FINITE-ENERGY SUM RULE AND CURRENT ALGEBRA. Eguchi, Tohru (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 3, 857-64(Sep 1971).

Rigorous treatment of the infinite momentum technique in current algebra is given by the use of the finite-energy sum rule method. As an application, a modified Adler–Weisberger relation which holds even in the case of $\Delta\sigma = \sigma_{\pi^- p}(\infty) - \sigma_{\pi^+ p}(\infty) \neq 0$, is derived and is shown to be identical with the Weinberg–Tomozawa relations. (auth)

7835 LOCALIZED STATES FOR ELEMENTARY SYSTEMS. Biritz, H. (Georgia Inst. of Tech., Atlanta). Nuovo Cim.; 6A: No. 2, 175-202(21 Nov 1971).

It is argued that the concept of localization for elementary systems is inherently ambiguous as in the example of an extended body in classical physics, and that there do not exist uniquely defined localized states. Two sets of invariance requirements for the determination of localized states are discussed. Besides rederiving the results of Newton and Wigner, the consequences of postulated Lorentz invariance of localization are studied. The corresponding Lorentz-invariant localized states are not uniquely determined. As all of these different types of states are completely equivalent, for all macroscopic kinematic purposes all of them are accepted as possible candidates for localized states. It is speculated that different types of elementary systems might require different types of localized states for their description. These localized states are useful for the enumeration of all possible relativistic wave functions, quantum field operators and relativistic wave equations one can associate with a given elementary system. (auth)

7836 PRISM PLOT: A NEW ANALYSIS OF MULTIBODY FINAL STATES. Brau, J. E.; Dao, F. T.; Hodous, M. F.; Pless, I. A.; Singer, R. A. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098.

A new technique for analyzing multibody states is presented. This analysis makes possible the selection of samples of events that contain only resonances, particle correlations, or phase space. A unique feature of this analysis is that every event in the data is assigned to a particular sample. The three-body final state $\pi^+ + p \rightarrow p + \pi^+ + \pi^0$ is analyzed as an example. (auth)

7837 ARE RESONANCE RESIDUES REAL? Henyey, Frank (Univ. of Michigan, Ann Arbor). Amer. J. Phys.; 39: No. 12, 1477-9(Dec 1971).

It may appear that the real analyticity and unitarity conditions on a scattering amplitude should imply that the residues of resonances are real, just as the residues of bound states are real. The residues are extracted in two simple models, a potential $U(r) = A\delta(r - r_0)$ and a K-matrix model. The amplitudes in these models are real analytic and unitary, yet the resonances have complex residues, as indeed they should. Based on the latter of these models the imaginary part of the ρ meson's residue is estimated as an interesting case in hadronic physics. (auth)

7838 RELATIVISTIC POLARIZED DENSITY MATRIX FOR PARTICLES WITH ARBITRARY SPIN. Gronskii, V. K. (Minsk State Pedagogical Inst.). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 4, 78-84(1971). (In Russian).

Using relativistic invariant equations of the first order and a covariant description of spin, a relativistic polarized density matrix was constructed for particles with arbitrary spin. A general formula was found for the operators of the polarized momenta. (tr-auth)

7839 HIGH ENERGY PHYSICS INDEX. VOLUME 9, NO. 24, 1971. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 67p.

7840 HIGH ENERGY PHYSICS INDEX. VOLUME 9, NO. 23, 1971. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 69p.

7841 CONNECTION BETWEEN LIFETIME AND WIDTH FOR BROAD RESONANCES. Redei, L. B. (Univ. of Umea, Sweden). Nuovo Cim.; 6A: No. 3, 430-7(1 Dec 1971).

The connection between the width of a broad maximum in the cross section and the lifetime of the corresponding metastable state is investigated in elastic single-channel scattering. An upper bound on the width is derived valid under the assumption that the maximum is due to a metastable state. (auth)

7842 ORIGIN AND COMPOSITION OF ULTRAHIGH ENERGY COSMIC RAYS. Stecker, F. W. (Goddard Space Flight Center, Greenbelt, Md.). Nature (London) Phys. Sci.; 234: No. 45, 28-9(8 Nov 1971).

The energy spectrum characteristics on which discussions of the origin of ultrahigh energy cosmic rays have centered are first described, and it is suggested that the absence of a flattening above 3×10^{18} eV may have implications for the discussions. Models for the origin are classified as I (galactic), II (extragalactic, low red shift) and III (extragalactic, high red shift), and models for composition are designated P (proton), H (heavy), and N (neutrino), and these models are discussed. It is found necessary to elaborate further by designating the models as I–P, II–H, III–N and so on. Compatibility with γ-ray observations is considered. On the basis of the discussion presented it would seem that heavy composition is indicated, and that recent air shower studies seem to favor the galactic origin model. (UK)

7843 CONTRIBUTION OF SECONDARY NUCLEAR CASCADING TO MULTIPLICITIES IN HIGH-ENERGY JETS IN EMULSION. Gibbs, R. E. (Univ. of Washington, Seattle); Lord, J. J.;

Goza, E. R. pp 639-50 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. III. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.3).

The multiplicity data observed in high-energy interactions in photographic emulsion show several characteristics which can be explained qualitatively by a simple model of secondary nuclear cascading. Within the context of the empirical model, multiplicities obtained in emulsion experiments are shown to be consistent with the proton-proton multiplicities observed by Jones, Erickson et al., University of Michigan report, 1970, with a liquid hydrogen target. (auth)

7844 POSSIBILITY OF EXISTENCE OF A NEW PROCESS AT INTERACTIONS WITH ENERGIES ABOVE 10^{12} eV. Gawin, J. (Inst. of Nuclear Research, Lodz, Poland); Maze, R.; Wdowczyk, J. pp 723-39 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. III. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.3).

The investigation of cosmic rays during the last decade gave the discovery of some phenomena which are difficult to explain within generally accepted model of high energy interactions. Among these phenomena one can quote the so-called X-process reported by Keuffel et al., the horizontal air showers reported by Tokyo group and the mu-poor showers reported and discussed in papers of the Polish-French group. It is shown that the three rather strange phenomena can be explained simultaneously if existence of a new process in interactions above 10^{12} eV is assumed. The essential feature of the process is the production of a massive particle with relatively long life and some small activity. The cross section of the process should be approximately by 2 to 3 orders of magnitude smaller than that of nuclear interactions. (auth)

Electromagnetic

Refer also to abstract 8045.

7845 (DESY-71/59) REFINED VECTOR MESON DOMINANCE ANALYSIS OF SINGLE PION ELECTROPRODUCTION. Fraas, H.; Schildknecht, D. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct 1971. 15p. Dep. NTIS (U. S. Sales Only).

Vector meson dominance predictions using all available $\pi^- p \rightarrow \rho^0 n$ data are compared with single pion electroproduction directly relating longitudinal ρ^0 production to the longitudinal electroproduction cross section. (auth)

7846 (DESY-71/60) QUARK MODEL RELATIONS FOR THE ELECTROPRODUCTION OF PSEUDOSCALAR MESONS. Krammer, Margarete (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct 1971. 8p. Dep. NTIS (U. S. Sales Only).

Electroproduction of pseudoscalar mesons $e + p \rightarrow e' + \pi^+ + n$, $e + p \rightarrow e' + \pi^+ + \Delta^0$, $e + p \rightarrow e' + K^+ + \Lambda$, $e + p \rightarrow e' + K^+ + \Sigma^0$, etc. is suggested as a further test of the symmetry relations implied by the quark model. The predictions are compared with recent experimental data. (auth)

7847 HEAVY LEPTONS AND THE MAGNETIC MOMENT OF THE MUON. Pietschmann, H.; Stremnitzer (Univ., Vienna). Phys. Lett.; 37B: No. 3, 312-14(29 Nov 1971).

Possible existence of a heavy muon, decaying into muon and photon influences the magnetic moment of muons. This contribution is calculated. It is logarithmically divergent. The result for various cut-off values is plotted and discussed. (auth)

7848 QUARK-PARTON MODEL FOR ELECTROMAGNETIC MASS DIFFERENCES OF THE HADRONS. Goldberg, H.; Srivastava, Y. N. (Northeastern Univ., Boston). Phys. Rev., D; 4: No. 5, 1426-8(1 Sep 1971).

The Cottingham formula for electromagnetic mass differences reveals possible logarithmic divergences as a result of the observed scaling behavior of the inelastic form factors W_1 and νW_2. A parton model of hadrons, in which the canonical quarks are present in an arbitrary sea of partons common to the members of an isomultiplet, is seen to eliminate this divergence for all the $\Delta I = 2$ cases, and for none of the $\Delta I = 1$ cases. (auth)

7849 DYNAMICAL AND KINEMATICAL ASPECTS OF CORRECTIONS TO SCALING BEHAVIOR. Schnitzer, Howard J. (Brandeis Univ., Waltham, Mass.). Phys. Rev., D; 4: No. 5, 1429-34(1 Sep 1971).

Nonscaling corrections to the scaling behavior of deep-inelastic scattering are discussed within the context of light-cone analysis. It is shown that there are both kinematical and dynamical corrections to scaling, derived from the leading and nonleading light-cone singularities, respectively. It is suggested that such corrections have already been observed, as evidenced by the improved fit to the SLAC data in the variable $\omega' = -q^2/(2\nu + m^2)$. Theoretical implications of these corrections are discussed. (auth)

7850 COMPTON SCATTERING AND ρ^0 PHOTOPRODUCTION AT HIGH ENERGIES. Fuchs, Norman H. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 4: No. 5, 1567-9(1 Sep 1971).

A recently proposed model for high-energy vector-meson photoproduction is extended to Compton scattering. The predicted differential cross section is in agreement with experiment in both shape and magnitude. (auth)

7851 BOUND FOR THE HADRONIC CONTRIBUTIONS TO THE ANOMALOUS MAGNETIC MOMENT OF THE MUON. Palmer, David (Univ. of Rochester, N. Y.). Phys. Rev., D; 4: No. 5, 1558-60(1 Sep 1971).

A rigorous bound is calculated for the hadronic contribution to the anomalous magnetic moment of the muon. The bound is free of phenomenological input; only the analyticity of the pion electromagnetic form factor is assumed. An improved bound is then calculated by using the experimental value of the electromagnetic radius of the pion as input. (auth)

7852 s-CHANNEL DOMINANCE AND CHARGE RATIOS IN HIGH-ENERGY PION PHOTOPRODUCTION. Barbour, I. (Glasgow Univ., Scotland); Malone, W.; Moorhouse, R. G. Phys. Rev., D; 4: No. 5, 1521-31(1 Sep 1971).

It is shown that an explicit quark model, or duality diagrams, imply certain charge ratios of the squares of the imaginary parts of the amplitudes for $\gamma N \rightarrow \pi^{\pm} N$ and $\gamma N \rightarrow \pi^{\pm}\Delta$, which are observed to hold in experiments on the high-energy cross sections $d\sigma/dt$ for $-0.2 \geq t \geq -0.8$ GeV^2. A fixed-t dispersion-relation calculation, using knowledge of the low-energy photoproduction amplitudes, suggests that this may be due to cancellation of the contribution of the low- and medium-energy s- and u-channel resonances to the real parts of the amplitudes, so that the s channel dominates the dispersion integral, and the quark-model relations also apply to the real parts of the amplitudes. In the extreme forward direction $[(-t)^{1/2} \lesssim 0.2]$ the fixed-t dispersion relations indicate that the $\gamma N \rightarrow \pi^{\pm} N$ amplitudes are predominantly real and dominated by the contributions to the dispersion relations of the Born approximation and other very-low-energy resonances. Some possible implications for purely hadronic reactions are discussed. (auth)

7853 PHOTOPRODUCTION OF MASSIVE MUON PAIRS AT HIGH ENERGIES. Jaffe, Robert L. (Stanford Univ., Calif.). Phys. Rev., D; 4: No. 5, 1507-20(1 Sep 1971).

The high-energy photoproduction of massive muon pairs off protons is studied in the framework of a field-theoretical parton model. Parton annihilation is found to contribute to the production of high-mass symmetric pairs. This contribution is important for events where a substantial fraction of the incident proton's momentum appears in the hadronic final state. It may be separated from the large background of Bethe-Heitler muon pairs by measuring a cross section differential in the longitudinal momentum of the muons. A scaling law is derived for the parton-annihilation contribution, showing that the cross section measures the as yet unexplored structure function of the photon. Other mechanisms of muon pair production are discussed and shown to be negligible in the region where the parton effect is important. Finally, it is shown that the parton contribution is observable despite the experimental complication of integrating the cross section over a bremsstrahlung-photon spectrum. (auth)

7854 PHOTON-PHOTON INTERACTIONS VIA ELECTRON-ELECTRON AND ELECTRON-POSITRON COLLIDING BEAMS. Brown, R. W. (Case Western Reserve Univ., Cleveland); Muzinich, I. J. Phys. Rev., D; 4: No. 5, 1496-1506(1 Sep 1971).

Some techniques are presented for studying the virtual photon-photon interaction available through electron-electron and electron-positron colliding beams. The two-photon processes are analyzed with the helicity methods presented before by Muzinich, Wang, and Wang, and with invariant amplitudes in the special case of forward elastic photon-photon scattering. A discussion of the high-energy behavior of some particular hadron production amplitudes as determined by Regge theory is given. In particular, the possibility of measuring the real photon-photon hadron production cross sections is emphasized. If only the final lepton momenta are measured and one attempts to isolate the total real photon-photon cross section into hadrons, there are electromagnetic background effects that may make this measurement difficult. (auth)

7855 COMMENT ON $\gamma\pi \rightarrow \pi\pi$ IN THE VENEZIANO MODEL. Schiller, D. H. (Univ. of Timisoara, Rumania); Stamatescu, I. O. Phys. Rev., D; 4: No. 5, 1569-71(1 Sep 1971).

It is shown that the Veneziano-type amplitude of Cooper for the process $\gamma\pi \to \pi\pi$ does not reproduce the experimental data as extracted from $\pi N \to \pi N\gamma$. (auth)

7856 NONLEADING ENERGY BEHAVIOR AND THE BREAKING OF SCALE INVARIANCE IN νW_2. Close, Francis E.; Gunion, J. F. (Stanford Univ., Calif.). Phys. Rev., D; 4: No. 5, 1576-9 (1 Sep 1971).

A recently proposed Regge model for describing the general features of on- and off-shell Compton scattering, using a simple form of scale-invariance breaking in q^2, is discussed and confronted with recent data. It is suggested that the mass size characteristic of the scale-invariance breaking is indicative, as well, of the relative contributions of the Pomeranchukon, $f-A_2$, and additional nonleading power behavior. The observed rapid approach to "scaling" in q^2 (at given ν) is seen to require a small characteristic mass which in turn requires a substantial nonleading contribution to the scaling function νW_2. Continuation of the resulting form to on-shell scattering predicts a nonleading power contribution to $\sigma_{tot}(\gamma p)$; a recent continuous-moment sum-rule analysis is consistent with this prediction. (auth)

7857 TWO-PHOTON MECHANISM OF PARTICLE PRODUCTION BY HIGH-ENERGY COLLIDING BEAMS. Brodsky, Stanley J. (Stanford Linear Accelerator Center, Calif.); Kinoshita, Toichiro; Terazawa, Hidezumi. Phys. Rev., D: 4: No. 5, 1532-8(1 Sep 1971).

The calculation of the cross sections for the production of positive-charge-conjugation states such as π^0, η, e^+e^-, $\mu^+\mu^-$, and $\pi^+\pi^-$ by a two-photon mechanism in e^-e^+ and e^-e^- collisions. The precise relationship of the process $e + e \to e + e + X$ (X is any C = + state) to the corresponding two-photon annihilation process $\gamma + \gamma \to X$ is given, as well as a careful derivation of the equivalent-photon approximation. In the case of the π^0 production, it was found that, for the beam energy E in the 1 to 3 GeV range, the exact total cross section is 20 to 30% larger than the one calculated previously in the equivalent-photon approximation. However, the introduction of form factors cuts down the exact total cross section, reducing it to within 10% of the equivalent-photon-approximation result. For η production the agreement is even better. Thus it appears that the use of the equivalent-photon approximation is justified in most cases. Detailed angular distributions in this approximation are discussed for the case of $\pi^+\pi^-$ production. One important problem which cannot be adequately studied in the equivalent-photon approximation is the degree of noncoplanarity of the $\pi^+\pi^-$ (and the $\mu^+\mu^-$) pair. This problem was studied using the exact formula and found that, for E = 1 GeV, typically 40 to 50% of pion pairs will be produced with the noncoplanarity angle greater than 12°. The general structure of the $\gamma + \gamma \to \pi^+ + \pi^-$ amplitude as well as a simple model incorporating the σ meson. A rough estimate of multi-hadron production cross section is also given. (auth)

7858 HADRON PRODUCTION BY HIGH ENERGY ELECTRON COLLIDING BEAMS. Budnev, V. M.; Ginzburg, I. F. (Mathematical Inst., Novosibirsk, USSR). Phys. Lett.; 37B: No. 3, 320-5(29 Nov 1971).

The mechanism of hadron production in high $e^-e^{\mp}$ collisions is investigated. The cross section of the two-photon process increases as $\ln^4 E$ and becomes dominant at $E \approx 2$ GeV, $\sigma_4 \approx 10^{-32}$ cm^2. A method to extract from experiment information about the $\gamma\gamma$ cross-section as function of s and q^2 is indicated. The possibility of the appropriate experiments by the missing mass method is estimated and the possibility of measuring mass, spin and width of C-even mesons is shown. (auth)

7859 PION COMPTON SCATTERING, e^+e^- ANNIHILATION INTO HADRONS, AND ELECTROMAGNETIC FORM FACTORS. Moffat, J. W.; Snell, V. G. (Univ. of Toronto). Phys. Rev., D; 4: No. 5, 1452-9(1 Sep 1971).

A model of pion Compton scattering is formulated on the basis of Regge poles and scale invariance. The structure functions for $e^+ + e^- \to \pi^\pm$ + hadrons are derived from those for electroproduction by using crossing symmetry, and the cross section for e^+e^- annihilation is calculated by assuming factorization of the Regge residues. The predicted cross section is consistent with recent storage-ring experimental results. The proton and pion electromagnetic form factors are then calculated from finite-energy sum rules and good agreement with the data is obtained. It is found that the e^+e^- annihilation cross section is not inconsistent with a pion form factor which decreases rapidly with increasing momentum transfer squared. (auth)

7860 SEARCH FOR MAGNETIC MONOPOLES. Kolm, Henry H. (Massachusetts Inst. of Tech., Cambridge); Villa, Francesco; Odian, Allen. Phys. Rev., D; 4: No. 5, 1285-96 (1 Sep 1971).

If magnetic monopoles exist, they are evidently too massive to have been produced in man-made radiation, too rare to have been observed directly in cosmic radiation, and too energetic to have accumulated in ferromagnetic surface minerals. Primordial monopoles which escaped immediate recombination would be destined to undergo progressive acceleration by the solenoidal magnetic fields they would encounter in the universe. They would by now have acquired energies of the order of 10^{20} eV and should therefore arrive isotropically, unaffected by the earth's atmosphere or magnetic field. Secondary monopoles produced in the upper atmosphere are also likely to have more residual energy than they can lose to the atmosphere. Ocean water of more than the penetration depth would thermalize monopoles without immobilizing them, and thus allow monopoles to accumulate in the magnetic component of deep-sea sediment. The slow deposition rate of sediment thus makes it the most promising terrestrial source of monopoles. Apparatus capable of extracting magnetic monopoles from massive quantities of sediment, accelerating them to 50 GeV and detecting them by an array of scintillation counters was constructed. Assuming that monopoles are bound only to ferromagnetic and paramagnetic materials, an upper-limit arrival rate of 1 per cm^2 in 8×10^{16} sec for an energy $\leq 4 \times 10^{15}$ eV, and 1 per cm^2 in 6×10^{17} sec for an energy $\leq 2 \times 10^{14}$ eV, was established for monopoles of either polarity, of charge larger than $\frac{1}{6}$ of the Dirac value, and of mass up to 14,000 proton masses, with a confidence level of 95%. For comparison, the arrival rate of particles generating extensive air showers accounting for more than 10^{18} eV is 1 per cm^2 in 1.5×10^{16} sec. (auth)

7861 APPLICATION OF A SEPARABLE-POTENTIAL MODEL TO p-p FINAL-STATE INTERACTIONS IN $\gamma + d \to \pi^- + p + p$. Gardiner, C. W. (Oxford Univ., Syracuse Univ., N. Y.). Phys. Rev., D; 4: No. 5, 1391-1401 (1 Sep 1971).

Wave functions calculated by using a new separable potential to which has been added a Coulomb potential are used to give an impulse-approximation treatment of p–p final-state interactions, which are compared with n–n and n–p final-state interactions. The treatment involves the choice of a potential which gives exact analytic solutions to the Schrödinger equation, so that no approximations are made which might destroy the completeness and orthogonality of the wave functions used. Computations for $\gamma + d \to \pi^- + p + p$ are carried out with the model, and it is concluded that no Coulomb effects should be noticeable when a bremsstrahlung beam is used as the γ source. (auth)

7862 REGGE POLE MODEL FOR CHARGED PION PHOTOPRODUCTION. Murai, Nobuyuki; Nakazawa, Nobuya; Okamura, Hiroshi; Sakai, Norisuke; Shimizu, Yoshimitsu (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 3, 808-19(Sep 1971).

A fit to high energy charged pion photoproduction in the relatively forward direction is performed on the basis of a Regge pole model, where the existence of the pion conspirator is assumed to explain the sharp forward peak. New experimental data on the asymmetry in the cross sections between two states of the polarization of the initial proton normal to the plane of scattering are taken account of, in addition to the other available data up to the present. Good fits are obtained with the inclusion of the strong fixed pole effect for the ρ residue function at the wrong signature nonsense point $\alpha_\rho(t) = 0$. It also becomes clear that the ρ and A_2 trajectories play very important roles in the region $0.3 < \sqrt{-t} < 0.7$. Furthermore the difficulty of pion conspiracy in connection with the reaction $\pi^+p \to \rho^0\Delta^{++}$ is discussed. (auth)

7863 SPINOR LADDER MODELS AND THE ASYMPTOTIC BEHAVIOR OF NEUTRAL PION PHOTOPRODUCTION AMPLITUDES. Sakai, Norisuke (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 3, 846-56(Sep 1971).

The asymptotic behaviors of nucleon–antinucleon scattering and π^0-photoproduction off a proton are calculated in perturbative ladder models whose sides are both spinor lines. Spins of the particles are treated correctly. Non-integer fixed branch points of the square-root type in complex angular momentum plane are found to dominate the amplitudes when s goes to minus infinity with t fixed. This disproves the previous conjecture that the right signature fixed pole at J = 0 may dominate the π^0-photoproduction amplitude in the spinor ladder model, and seems to make the fixed pole unsatisfactory in explaining the experimental behavior $s^2 d\sigma/dt$ = constant.

7864 CURRENT INTERACTIONS IN A PARTON PICTURE. Ezawa, Zyun F. (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 3, 883-96(Sep 1971).

A parton picture is formulated in the context of the interaction representation of field theory by requiring the importance of infinitely intricate Feyman diagrams. Partons are supposed to be usual bare particles such as protons and pions. Electromagnetic interactions are studied in this picture. From the time-ordered product of two currents, singular terms on the light-cone are separated. The singularity is shown to be generated by the exact Feynman propagators of partons. The regular term turns out to be concerned with the vector meson dominance model. The deep-inelastic electron–proton scattering is examined in the model. The threshold behavior of the structure function due to the pion-current is found to be the same as the one due to the proton-current, namely, $\sim(\omega - 1)^3$. (auth)

7865 MODEL FOR DIPOLE ELECTROMAGNETIC FORM FACTORS. Yamada, Masao (Univ. of Texas, Austin). Progr. Theor. Phys. (Kyoto); 46: No. 3, 865-73(Sep 1971).

A model of the electromagnetic form factor of the scalar π meson is discussed in which the π meson is a bound state of scalar nucleon–antinucleon system. Starting from an exact integral representation of the form factor, which is well defined in a space-like region of the momentum transfer squared, q^2, an analytic continuation of the representation is performed under some plausible assumptions on dynamics and a simple pole definition of a resonance in the π-N scattering amplitude. It is shown that the singularities of the form factor corresponding to resonances turn out to be dipoles and not simple poles contrary to the widely held belief. A generalization to the other hadron cases is discussed in the quark model scheme. (auth)

7866 ELECTROPRODUCTION OF NUCLEON RESONANCES IN A RELATIVISTIC QUARK MODEL. Ravndal, F. (California Inst. of Tech., Pasadena). Phys. Rev., D; 4: No. 5, 1466-74 (1 Sep 1971).

A relativistic version of the symmetric quark model is used to calculate the inelastic electron–proton scattering amplitudes in the resonance region. Including all the nucleon states of the harmonic-oscillator baryon spectrum, good agreement is found with the three prominent peaks in the cross section. The part of the cross section coming from longitudinally polarized virtual photons is small, as recently observed in the resonance region. (auth)

7867 HADRONIC PRODUCTION IN e^+e^- COLLISIONS. Layssac, J.; Renard, F. M. (Dept. de Physique Mathematique, Montpellier, France). Nuovo Cim.; 6A: No. 2, 134-50(21 Nov 1971).

The hadronic production in e^+e^- collisions is studied in the framework of the vector-dominance model. The cross sections are supposed to be dominated by the quasi–two-body final states coupled to the ρ, ω, and φ mesons. The results are given for $e^+e^- \rightarrow 4\pi, 5\pi, 6\pi, \eta + 2\pi, \eta + 3\pi, \eta + 4\pi, K\bar{K} + 2\pi, K\bar{K} + 3\pi, K\bar{K} + 4\pi$. In the range $E_{tot} < 3$ GeV, it appears that the cross sections are of the order of 10^{-32} cm^2, in agreement with the measurements made with Adone. (auth)

7868 TRANSPARENCIES OF COMPLEX NUCLEI TO PHOTOPRODUCED PIONS AND RECOIL NUCLEONS. de Carvalho, H. G. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro); Martins, J. B.; Tavares, O. A. P.; Nazareth, R. A. M. S.; di Napoli, V. Notas Fis., Cent. Brasil. Pesqui. Fis.; 17: No. 4, 217-33(1971).

The calculation of transparencies for pions and nucleons originating from the reaction of 0.3- to 1.0-GeV photons with complex nuclei is reported. The nuclei carbon-12, sodium-23, aluminum-27, manganese-55, ruthenium-100, rhodium-103, iodine-127, gold-197, bismuth-209, thorium-232, and uranium-238 are considered. (J.F.P.)

7869 $\gamma + \gamma \rightarrow 3\pi^0$ AND $\pi^+ + \pi^- + \pi^0$ IN A LINEAR σ MODEL. Wong, T. F. (Rutgers–The State Univ., New Brunswick, N. J.). Phys. Rev. Lett.; 27: No. 23, 1617-21(6 Dec 1971).

The low-energy limit of the one-loop contribution to $\gamma + \gamma \rightarrow 3\pi^0$ and $\pi^+ + \pi^- + \pi^0$ in a linear σ model is presented. In this model calculation one has the Adler–Schwinger anomaly and one does not have to set all pion momenta equal to zero. The result maintains gauge invariance and both amplitudes vanish in contradiction to the previous result of Aviv, Hari Dass, and Sawyer. (auth)

7870 CLASSICAL HAMILTONIAN THEORY FOR PARTICLES WITH SPIN. Plahte, E. (Agricultural Coll. of Norway, Vollebekk). Phys. Norv.; 3: No. 3, 243-62(1969).

Using a generalized (noncanonical) Poisson bracket formalism, a classical Hamiltonian theory for particles with spin in external electromagnetic fields is established. The fundamental variables from which the physical variables are constructed are chosen such that the Poincaré group algebra can be generated by a set of classical "generators" via the generalized Poisson brackets. The "generators" are expressed as functions of the fundamental variables, but they can also be given in terms of the physical variables in the usual manner. This ensures invariance of theory under the Poincaré group. The generalized Poisson bracket relations between the physical variables and the equations of motion are derived. The equations of motion do not admit Zitterbewegung and are in accordance with previous results. In the case of vanishing external fields, the physical variables are shown to be equivalent to previously known expressions. A quantization of the theory and a comparison with the semiclassical limit of the Dirac–Pauli theory for spin-$\frac{1}{2}$ is carried out. In the approximation considered, the two theories are equivalent. Finally, the position variable is interpreted and related to other previously known variables. From the interpretation of the position variable it is concluded that the theory describes an extended particle. (auth)

7871 PAIR PRODUCTION IN A VARYING EXTERNAL FIELD (QUASICLASSICAL APPROXIMATION). Popov, V. S. (Inst. of Theoretical and Experimental Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 4, 1334-51(Oct 1971). (In Russian).

A quasiclassical method is developed for calculating the probability for pair production in a varying electromagnetic field. The conditions of applicability of the method are: $E \ll m^2c^3/e\hbar$, $\hbar\omega \ll mc^2$, where ω is the effective field variation frequency, E is the field amplitude and m mass of the particles produced by the field. Underlying the method is the concept of sub-barrier particle motion taking place along a classical trajectory but for an imaginary value of "time". The exact Green function for the Dirac equation in an external field is not required and the method can be applied to a very broad class of fields. (auth)

7872 EFFECT OF ELECTRON BETATRON OSCILLATIONS ON THE PROPERTIES OF SYNCHROTRON RADIATION. Zhukovskii, V. Ch.; Shishanin, O. E. (Moscow State Univ.). Zh. Eksp. Teor. Fiz.; 61: No. 4, 1371-8(Oct 1971). (In Russian).

The spectral-angular distribution and polarization properties of synchrotron radiation emitted by an electron in an axially-symmetric weakly focusing magnetic field is considered by taking into account betatron oscillations and quantum effects. It is shown that the degree of effect of magnetic field inhomogeneity on the radiation is determined by the parameter $g = \sqrt{qBR^{-1}}/mc^2E^{-1}$ (q is the inhomogeneity index, and R radius of the equilibrium circular orbit). The distributions obtained differ most from respective distributions for homogeneous fields when $g \gtrsim 1$. Theoretical curves are plotted which explain the experimentally observed absence of completely linearly polarized radiation propagating in the plane of the equilibrium orbit. (auth)

7873 EXCHANGE CURRENTS AND SOFT PHOTONS. Liou, M. K.; Sobel, M. I. (Brooklyn Coll.). Phys. Rev., C; 4: No. 5, 1507-10(Nov 1971).

The validity of the low-energy theorem for emission of soft photons is verified in the case of two particles that interact via an exchange potential. The amplitude for emission from exchange currents is defined to lowest order in K, the photon momentum; it cancels part of the amplitude arising from internal nucleon lines. Comparison is made with the definition of exchange currents made by other authors. (auth)

7874 CONSEQUENCES OF QUARK MODEL FOR PHOTOPRODUCTION PROCESSES OF NEUTRAL VECTOR MESON ON NUCLEONS. Rekalo, M. P. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 4, 590-5(Apr 1971). (In Russian).

The consequences are analyzed of the very general variant of the quark model for the neutral vector meson photoproduction processes. It is shown that additivity of the quark model without additional assumptions on the relative values of the quark amplitudes results in the equality of the differential cross sections of φ-photoproduction on the proton and neutron, and in the equality of the differences of the ω- and ρ-photoproduction cross sections on the proton and neutron. The greatest general relation is found between the V^0-photoproduction cross-sections for $t = 0$ and the total cross sections of π- and K-meson interaction with nucleons. The V^0-photoproduction cross sections on nuclei of D, ^{3}He, ^{3}He are calculated in the impulse approximation. (auth)

7875 PHOTOPRODUCTION OF NEUTRAL PSEUDOSCALAR MESONS ON NUCLEI. Kobylinskii, N. A. (Inst. of Theoretical Physics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 4, 596-9 (Apr 1971). (In Russian).

The processes of the meson photoproduction on nuclei are considered in a model taking into account poles and cuts parameters of which are connected in the impulse approximation with those of contributions from these singularities to the amplitude of the meson photoproduction on nucleons. The possibility of determining the relative sign of the Coulomb and Regge amplitudes in the processes of the coherent meson photoproduction on nuclei with zero isospin is shown. (auth)

7876 WEAK-INTERACTION CORRECTIONS TO THE ANOMALOUS MAGNETIC MOMENTS OF THE LEPTONS. Jarlskog, C. (CERN, Geneva). Nuovo Cim.; 6A: No. 3, 350-64 (1 Dec 1971).

The quadratically divergent contribution of the current-current weak interactions to the anomaly of the leptons is calculated using the Pauli-Villars regularization prescription à la Gupta. This contribution is found not to be zero, contrary to what has been found in the literature. As a by-product of the calculations, formulas for the weak contribution to the energy levels of the leptonic atoms are derived. It is noted incidentally that the neutrino loop exhibits an anomaly similar to that arising in the study of the divergence of the axial vector current. (auth)

7877 AXIAL-VECTOR NUCLEON FORM FACTOR FROM PION ELECTROPRODUCTION ON A PROTON. Titov, Yu. I.; Severin, N. F.; Afanas'ev, N. G.; (and others) (Physical-Technical Inst., Kharkov). Phys. Lett.; 37B: No. 4, 422-3(13 Dec 1971).

The results of the analysis for the cross section of threshold pion electroproduction on protons in the range of squared four-momentum transfers 2.4 – 4.9 fm^{-2} are presented. The validity of a current algebra method and the PCAC hypothesis for the description of pion electroproduction is shown. The values of an axial-vector form factor are obtained. (auth)

7878 REFINED VECTOR MESON DOMINANCE ANALYSIS OF SINGLE PION ELECTROPRODUCTION. Fraas, H.; Schildknecht, D. (DESY, Hamburg). Phys. Lett.; 37B: No. 4, 389-92(13 Dec 1971).

Vector meson dominance predictions using all available $\pi^- p \rightarrow \rho^0 n$ data are compared with single pion electroproduction relating longitudinal ρ^0 production to the longitudinal electroproduction cross section. (auth)

7879 SCALING LAW OF ELECTROPRODUCTION AS A CONSEQUENCE OF BROKEN DILATATION SYMMETRY. Mack, G. (International Centre for Theoretical Physics, Trieste, Italy). Nucl. Phys.; B35: No. 2, 592-612(1971).

The scaling law of deep inelastic electroproduction is derived from broken dilatation symmetry. The analysis is based on Wilson's theory of symmetry breaking. Particular attention is paid to the possible existence of anomalous dimensions. (auth)

7880 ELASTIC SCATTERING OF ELECTRONS FROM POLARIZED PROTONS AND INELASTIC ELECTRON SCATTERING EXPERIMENTS. De Rujula, A. (CERN, Geneva); Kaplan, J. M.; de Rafael, E. Nucl. Phys.; B35: No. 2, 365-89(1971).

Rigorous bounds, to order $\alpha \simeq {}^1/_{137}$, are derived for the transverse polarization of protons in elastic electron-proton scattering. The bounds depend on the proton elastic form factors and on the proton inelastic structure functions. Numerical estimates of the bounds are made and the results are compared with the polarization data. Their theoretical meaning and their implications upon future experiments are discussed. (auth)

7881 CLASSICAL LIMIT OF LOW-ENERGY COMPTON SCATTERING. Goldhaber, Alfred S. (CERN, Geneva). Nucl. Phys.; B35: No. 2, 413-33(1971).

Classical techniques are used to compute $\hbar = 0$ Compton scattering. The results are compared with Lin's remarkable work, extending the quantum Compton low-energy theorem to order ω^3 (ω is photon frequency). Complete agreement is found, and ω^3 terms are confirmed quantum mechanically. The classical (Kramers) Hamiltonian for a spinning particle in an electromagnetic field is developed heuristically and also derived from quantum electrodynamics. The algebraically complicated $h \neq 0$ corrections are merely recoil effects imposed by Lorentz invariance. They appear non-trivially in the unpolarized cross section only at order ω^3. (auth)

7882 LOW-ENERGY THEOREMS FOR COMPTON SCATTERING ON A TARGET OF ARBITRARY SPIN. Stern, H. (CEN de Saclay, Gif-sur-Yvette, France). Nuovo Cim.; 6A: No. 3, 393-429(1 Dec 1971).

The so-called tensor method is applied for the first time to the study of Compton effect at low energy on a target of arbitrary spin. First low-energy theorems are derived for all multipolar amplitudes, independently of the constraints imposed by parity conservation and time-reversal invariance. Finally, these constraints are fully exploited in the study of the helicity amplitudes at second order in the energy of the photon which depend, in the general case of spin, on the electric charge, the magnetic moment and the electric quadrupole of the target and on four unknown polarizability parameters. (auth)

7883 COMMENTS ON THE ELECTRO-MAGNETIC FORM FACTORS. Senju, Hirofumi (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 46: No. 4, 1290-1(Oct 1971).

The data on the nucleon and pion form factors are examined from the standpoint of the sub-urbaryon model recently proposed by Senju (Prog. Theor. Phys. 46: 550 (1971). (L.B.S.)

7884 UNIVERSALITY OF THE FAMILY OF STRUCTURE FUNCTIONS. Iizuka, Jugoro; Kobayashi, Makoto; Nitto, Hidemitsu (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 46: No. 4, 1170-7(Oct 1971).

Previous analyses of deep inelastic lepton-hadron collisions are re-examined in the vanishing limit of the Pomeron contribution. It is shown that the universality of structure functions can be deduced from our basic postulates in this limit. A further extension of this result is discussed in connection with the conjectured existence of a single universal function. (auth)

7885 NEW APPROACH TO THEORY OF ELECTROMAGNETIC CASCADES. Thielheim, K. O.; Zoellner, R. (Univ., Kiel). pp 471-8 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. II. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708–(Vol.2).

An approach was made for the numerical treatment of cascade development that has advantages similar to Monte Carlo procedure but exhibits a considerably slower increase of computing time with increasing primary energy. Two methodically different approaches to the theoretical treatment of electromagnetic cascade development have been applied and the numerical treatment of the Boltzmann equation is applied. (J.C.W.)

7886 FIREBALL MASSES. Fujimoto, Y. (Waseda Univ., Japan); Lattes, C. M. G.; Mantovani, M. pp 619-22 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. III. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708–(Vol.3).

A previous method is applied to Fowler "Texas Lone Star," Proceedings Jaipur Conference, 1963, to obtain the given Shibata plots for fireball masses. Values for the pionic rest mass and laboratory system Lorentz factor of the observed data are obtained from fitting the universal Shibata correlation curves to the empirical data. Also a preliminary analysis of the atmospheric cascade associated with the event Andromeda shows that the particles of the corresponding cascade cannot be accounted for by a single gamma ray. (J.F.P.)

Weak

7887 (DESY–71/53) DEVELOPMENTS IN WEAK INTERACTIONS: THEORY. Oakes, R. J. (Northwestern Univ., Evanston, Ill. Dept. of Physics. Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Sep 1971. 23p. (CONF-710810–4). Dep. NTIS (U. S. Sales Only).

From Meeting on particles and fields; Rochester, N. Y. (30 Aug 1971).

After beginning with a brief review of the Cabibbo weak interaction, some of the recent developments in weak interaction theory are surveyed. The presentation is organized into first a discussion of developments in nonleptonic, leptonic and semileptonic interactions which will then be followed by selected topics of current interest that do not belong entirely to any one of these three categories of weak interactions. (auth)

7888 MEASUREMENT OF THE STRONG INTERACTION FORM FACTORS IN THE SEMILEPTONIC DECAYS OF THE LONG LIVED NEUTRAL K MESON. Resvanis, Leonidas Kyriakoulis. Baltimore; Johns Hopkins Univ. (1971). 185p. University Microfilms Order No. 71-29,178.

Thesis.

The results of a large statistics experiment studying the strong interaction form factors of the $K_L^0 \rightarrow \pi\mu\nu$ and $K_L^0 \rightarrow \pi e\nu$ decay modes are reported. A wire spark chamber spectrometer was used, and the experiment was performed at S. L. A. C. Using linear (in q^2) parametrization of $f_+(q^2)$ and $f_-(q^2)$ it is found from the $K_{\mu 3}$ analysis that $\lambda_+ = .06^{+.02}_{-.01}$, $\lambda_- = -.15^{+.05}_{-.1}$, $\xi(0) = -1.5 \pm 1$ and from the K_{e3} analysis $\lambda_+ = .052 \pm .01$. The data show that μ–e universality is satisfied and the $\Delta I = {}^1/_2$ rule is valid. (Diss. Abstr. Int., B)

7889 VIOLATION OF THE $|\Delta\hat{I}| = {}^1/_2$ RULE IN THE K_{l3} DECAYS. Oneda, S. (Univ. of Maryland, College Park); Yabuki, H.; Matsuda, Seisaku. Phys. Rev., D; 4: No. 5, 1459-66(1 Sep 1971).

The violation of the $|\Delta\hat{I}| = {}^1/_2$ rule in the K_{l3} decays is discussed in detail. The effect of broken symmetry on weak hadron currents is taken into account by applying the hypothesis of asymptotic SU(3) and SU(2) symmetries. No assumption is made about the mechanism of the SU(3) and SU(2) breakings except that both of them belong to an octet. The main effect turns out to be described essentially by the effect of the particle mixings which take place among the π^0, η^0, and η'^0 (958) mesons. It is shown that one of the solutions for these mixing parameters, which is compatible with the SU(3) and SU(2) mass splittings between the members of the pseudoscalar nonet, gives rise to a rather sizable violation of the $|\Delta I| = \frac{1}{2}$ rule in the branching ratios, and in particular, the sign of the violation is opposite to the one obtained by the usual consideration of the electromagnetic correction involving charged leptons. The solution predicts $R_e \simeq \Gamma(K_L \rightarrow \pi^{\pm}e^{\mp}\nu)/2\Gamma(K^+ \rightarrow \pi^0 e^+\nu) \simeq 0.94$ and also $R_e \simeq R_\mu$, where R_μ is the corresponding branching ratio for the muon decays. This seems to be consistent with the latest compilation of world data. A remark is also added on the semileptonic baryon processes in broken SU(3) and SU(2) symmetries. (auth)

7890 SPECULATIVE RELATION BETWEEN THE FINE-STRUCTURE AND FERMI COUPLING CONSTANTS. Terazawa, Hidezumi (Cornell Univ., Ithaca, N. Y.). Phys. Rev., D; 4: No. 5, 1579-81(1 Sep 1971).

It is pointed out that there exists a peculiar coincidence among several different predictions for the intermediate-boson mass: Both of the masses given by Lee and by the author are very close to $\alpha^{-1}M_p$ (where α is the fine-structure constant and M_p is the proton mass). By taking it seriously, the following two relations are obtained: $\alpha = (GM_p^2/6\sqrt{2}\pi)^{1/4} \simeq 1/137.5$ for the Fermi coupling constant G and $\sin\theta = 1/3$ for the Cabibbo angle θ. (auth)

7891 BOUNDS ON K_{l3} DECAY PARAMETERS. Aubrecht II, Gordon J.; Scott, David M.; Tanaka, K.; Torgerson, R. (Ohio State Univ., Columbus). Phys. Rev., D; 4: No. 5, 1432-5(1 Sep 1971).

Bounds on the coefficients of the linear and quadratic terms in the scalar and vector form factors for K_{l3} decay are obtained in the framework of chiral SU(3) ⊗ SU(3) breaking. (auth)

7892 COMMENTS ON CALCULATIONS OF KAON DECAY INTO TWO PHOTONS. Yndurain, F. J. (Univ. Autonoma, Madrid). Progr. Theor. Phys. (Kyoto); 46: No. 3, 990-2(Sep 1971).

Some errors and imprecisions in dispersive calculations of $K \rightarrow 2\gamma$ decay are pointed out. Solutions to the problem are suggested. (L.B.S.)

7893 PHENOMENOLOGY OF $K \rightarrow 2\pi$ DECAYS. Rasmussen, M. C.; Roper, L. David (Virginia Polytechnic Inst. and State Univ. Blacksburg). Phys. Rev., D; 4: No. 5, 1401-8(1 Sep 1971).

The theoretical expressions for experimentally determined quantities in $K \rightarrow 2\pi$ decays and leptonic kaon decays are used to determine solutions for various theoretical parameters. Two solutions are found: one for which the $|\Delta I| = \frac{1}{2}$ dominance rule is valid, and another for which it is not. Both solutions yield $\epsilon \cong \eta_{+-} \cong \eta_{00}$. Even precise measurements of ϕ_{00} may not allow one to distinguish between the two solutions. (auth)

7894 STRONG MESON DOMINANCE MODEL AND THE G-PARITY NON-CONSERVING WEAK INTERACTIONS. Igarashi, Masataka (Tokyo Univ.); Nakamura, Seitaro; Sato, Shigeo. Progr. Theor. Phys. (Kyoto); 46: No. 3, 874-82(Sep 1971).

Beta-decay interactions are derived on the strong meson dominance model in which, it is claimed, all strong mesons should make the main contributions to β-decay. By taking π, ρ, $\delta(960)$, $\pi_N(1016)$, $A_1(1070)$, and B(1220) as candidates for the intermediary mesons, and by assuming the weak interactions of V–A type between these mesons and the lepton currents, the β-decay interactions of V and A without momentum, and S, PS, T, and PT with momentum are derived, which have the same forms with those given by Weinberg. The necessary existence of the interactions PT and S which violate the G-parity conservation of the respective currents is then predicted. The interaction T which leads to the weak magnetism in the correct value and the interaction PS which corresponds to the induced pseudoscalar already well known are deduced. The predicted existence of the interaction S violates the conservation of the vector current. (auth)

7895 $|\Delta I| = \frac{1}{2}$ RULE FOR NONLEPTONIC KAON DECAYS, DUALITY, AND CURRENT ALGEBRA. Hosoya, Akio; Tokuda, Naoki (Tokyo Univ.) Progr. Theor. Phys. (Kyoto); 46: No. 3, 998-9(Sep 1971).

The $|\Delta I| = \frac{3}{2}$ parts of nonleptonic kaon decays are treated in the spurion formalism, assuming that the amplitudes are expressed by the four- and five-point Veneziano amplitudes and that certain current algebra relations hold. The results are shown to be incompatible with the Callen–Treiman relations between $K \rightarrow 2\pi$ and $K \rightarrow 3\pi$ decays. (L.B.S.)

7896 $K_L^0 \rightarrow 2\gamma$ DECAY THROUGH INTERMEDIATE W_1 AND W_0 BOSONS. Buchl, R. A.; Nigam, B. P. (Arizona State Univ., Tempe). Nuovo Cim.; 6A: No. 2, 241-4(21 Nov 1971).

A mechanism for the decay $K_L^0 \rightarrow 2\gamma$ is proposed. The closed-loop graph involves two W_1 bosons and the W_0 which was recently conjectured to exist by Lee. The calculated rate involves a cutoff Λ and the masses of the bosons m_1 and m_0. The experimental average for the branching ratio is used to obtain the relation $m_0 > 0.30\ \Lambda$, where m_0 is the mass of the spin-zero W_0 boson. (auth)

7897 NONLEPTONIC HAMILTONIAN, SU(3) BREAKING, AND THE $K_2^0 \rightarrow \gamma\gamma$ DECAY. Moshe, M.; Singer, P. (Technion-Israel Inst. of Tech., Haifa). Phys. Rev. Lett; 27: No. 24, 1685-8(13 Dec 1971).

The inclusion of SU(3) symmetry breaking in the PVV vertices and the use of the "simplest" Hamiltonian consistent with $\Delta I = \frac{1}{2}$ for nonleptonic $\Delta S = 1$ transitions bring the calculation of $K_2^0 \rightarrow \gamma\gamma$ decay mode into agreement with experiment, vis-a-vis the disagreement of two orders of magnitude previously reported. (auth)

7898 GENERALIZED GAUGE FIELDS AND APPLICATIONS TO WEAK INTERACTIONS. Chen, Tuan Wu (New Mexico State Univ., Las Cruces). Ann. Phys. (N. Y.); 67: No. 1, 145-57(Sep 1971).

Yang–Mills' field is generalized to possess a nontrivial scalar part. Ths most general transformations for such a field under the 3-parameter isotopic gauge transformation is obtained. Using this generalized gauge field, a gauge invariant Lagrangian is constructed within the framework of the quark model. Interactions for spin-1 as well as for spin-0 are generated. As a further application a weak interaction theory mediated by the generalized gauge (boson) field is formulated. The entire weak interactions are generated in two halves; the hadron–boson interaction is generated according to Yang–Mills' trick using the generalized gauge field and the other half (boson–lepton, etc.) is then generated by making use of the scalar part of the gauge fields according to the conventional pion gauge principle. The effective Lagrangian is then found to be mediated by the effective propagators which fall off as p^{-2} at high momenta; the unitarity of the theory can thereby be insured. Universality in weaker sense than the usual one is applied to the intermediate bosons; our theory for β-decay then reduces to Cabibbo's at low energy. (auth)

7899 GAUGE INVARIANT NONLOCAL THEORY OF THE WEAK INTERACTIONS. Efimov, G. V.; Seltser, Sh. Z. (Joint Inst. for Nuclear Research, Dubna, USSR). Ann. Phys. (N. Y.); 67: No. 1, 124-44(Sep 1971).

The perturbation theory of electromagnetic and weak interactions is considered. A hypothesis is proposed that the neutrino is a "carrier" of nonlocality. It means effectively a nonlocal change of the neutrino free-particle propagator. The charged lepton fields (electron and muon fields) are considered to be local; consequently, the gauge invariance of the theory is guaranteed. The introduction of the nonlocality does not remove all ultraviolet divergences in perturbation theory, but there is only a finite number of divergent Feynman diagrams that are formed by the closed charged lepton loops. Therefore, the theory is renormalized. The renormalization of the theory leads to the appearance of an additional pure ν–ν interaction. (auth)

7900 SOME POSSIBLE PROPERTIES OF WEAK INTERACTIONS AT HIGH ENERGIES. Azimov, S. A.; Arushanov, G. G. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk. SSSR; 198: No. 5, 1040-2(11 Jun 1971). (In Russian).

The existing theory of weak interactions is based upon assumptions as to the localizability of an interaction and the possibility of using perturbation theory. This leads to cross sections of effects with a quadratic energy dependence in the system of the center of inertia of colliding particles. A series of fundamental problems of the theory depends on what energies accompany an increase in cross section of weak interactions. And what maximum value is attained by these cross sections? It is shown that such values are probably not large. (K.S.W.)

7901 WEAK INTERACTION OF PHOTONS AND THE PROCESS $\nu + Z \rightarrow \nu + Z + \lambda^+ + \lambda^-$. De, S. S. (Serampore Coll., West Bengal, India); De, K. J. Phys., A (London); 4: No. 6, 923-7(Nov 1971).

The cross section for the process $\nu + Z \rightarrow \nu + Z + \lambda^+ + \lambda^-$, where $\lambda^{\pm}$ represents $e^{\pm}$ or $\mu^{\pm}$, was calculated from the point of view of the photon–neutrino weak coupling theory. The importance of this process to test the different theories of weak interactions was also discussed. (auth)

7902 DO MUONS INTERACT ANOMALOUSLY WITH HADRONS. Barshay, S. (Univ. of Copenhagen). Phys. Lett.; 37B: No. 4, 397-402(13 Dec 1971).

The possibility that the recently observed suppression of the rate for $K_L \rightarrow \mu^+\mu^-$ is due to the three-pion intermediate state with an anomalously large amplitude for $3\pi(J^P = 0^-) \rightarrow \mu^+\mu^-$ is examined. New dynamics are not explicitly introduced, but the empirically required enhancement is merely parameterized in the simplest phenomenological manner. The question is then raised as to whether this interaction would be presently observable in other experiments where muons are studied in the vicinity of hadrons, in particular muon-proton scattering and muonic atoms. The same question is also raised with respect to an alternative possibility, namely that of anomalously large amplitude for $\pi\pi(J^P = 0^+) \rightarrow \mu^+\mu^-$ gives rise to $K_S \rightarrow \mu^+\mu^-$. The possible size and nature of effects in other experiments are thus estimated. (auth)

7903 ELASTIC SCATTERING OF ELECTRONS BY FISSION ANTINEUTRINOS. Bandyopadhyay, P.; Chaudhuri, P. R. (Indian Statistical Inst., Calcutta). Nuovo Cim.; 6A: No. 3, 328-34(1 Dec 1971).

The scattering cross sections for the elastic-scattering reaction $\bar{\nu}_e + e^- \rightarrow \bar{\nu}_e + e^-$ taking into account the energy spectrum of electron-antineutrinos from ^{235}U fission were calculated according to the photon-neutrino weak-coupling theory for several values of minimum electron energy from 1 to 5.5 MeV. The results are then compared with those derived according to the V−A theory. It is found that the present experimental upper limit for the cross section as reported by Reines and Gurr is about 200 times the cross section predicted with the photon-neutrino coupling theory. Finally, the arguments put forward by Stothers for the astrophysical exclusion of the photon-neutrino coupling theory are discussed and shown to be invalid in view of various uncertainties entering into the calculation of stellar evolution. (auth)

7904 NEUTRINO PRODUCTION OF LEPTON PAIRS. I. Koike, Kazuo; Konuma, Michiji; Kurata, Koki; Sugano, Kimio (Kyoto Univ). Progr. Theor. Phys. (Kyoto); 46: No. 4, 1150-69(Oct 1971).

The neutrino production of a lepton pair in the electromagnetic field of the nucleus is treated. Using the local Fermi interaction together with the electromagnetic form factor of the nucleus, the differential cross section $d^2\sigma/dr_1dr_2$ is rigorously derived. In the case where the incident neutrino momentum and the two produced charged lepton momenta r_i are coplanar, the expression is completely analytical. The result is valid for (e,μ), (μ,μ) and (e,e) productions. (auth)

Strong (General)

Refer also to abstract 7769.

7905 (NYO-2262-TA-255) SHORT-RANGE CORRELATIONS IN TWO-PARTICLE PRODUCTIONS. Jen, Chian-li; Kang, Kyungsik; Shen, Pu; Tan, Chung-I (Brown Univ., Providence, R. I. Dept. of Physics). [1971]. 8p. Dep. NTIS.

Based on the analysis of the eight-point dual amplitude, it is shown that the two-particle distribution function exhibits a transverse momenta cutoff of the form, $\exp\{-4(p_1^{\perp 2} + p_2^{\perp 2} + 2p_1^{\perp}p_2^{\perp}\cos\beta)\}$, in the pionization region, where β depends on the relative rapidity y and the relative azimuthal angle ϕ between $\vec{p}_1^{\perp}$ and $\vec{p}_2^{\perp}$. Explicit correlation function indicates that the correlation function indicates that the correlation length in y is of the order 1. (auth)

7906 AREAS OF DEFINITION FOR RELATIVISTIC PARTIAL WAVE AMPLITUDES. Blazek, M. (Inst. of Physics, Bratislava). Fyz. Cas.; 20: No. 4, 195-210(1970).

The areas are described where the Mandelstam denominators of the partial wave amplitude vanish, up to the point where the momentum transfer squares and the scattering angle has physical values. If the so-called particle approximation is made only certain isolated physical branch cuts are met. The location of the physical branch lines can be considered to indicate the importance of exchange. If in the complex s-plane integration is performed along the physical branch lines continuation in cos δ-plane is not necessary—the fact which can be exploited in applying the particle approximation in the dynamic model of strong interactions. (NSA of Czech)

7907 DUAL QUARK–GLUON MODEL OF HADRONS. Schwarz, J. H. (Princeton Univ., N. J.). Phys. Lett.; 37B: No. 3, 315-19(29 Nov 1971).

A possible method for constructing a dual-resonance model of hadrons out of mathematical quarks and gluons is proposed. A quark emission vertex is derived. (auth)

7908 SEQUENTIAL PROJECTIONS OF REARRANGEMENT CHANNELS. Hahn, Yukap (Univ. of Connecticut, Storrs). Ann. Phys. (N. Y.); 67: No. 2, 389-405(Oct 1971).

A stepwise procedure of constructing the totally closed channel Hamiltonian for scattering systems with rearrangement processes, in which the non-orthogonal rearrangement-channel components are projected out in sequence, is proposed. The connection of this method to that followed in the generalized variational bounds formulation is clarified, and several possible applications are indicated. A simpler yet rigorous procedure for the evaluation of resonance energies is discussed with the partially projected operators. (auth)

7909 DUAL MODELS WITH MANDELSTAM ANALYTICITY. Bugrij, A. I.; Jenkovszky, L. L.; Kobylinsky, N. A. (Inst. for Theoretical Physics, Kiev). Nucl. Phys.; B35: No. 1, 120-32 (1971).

A class of dual models with Mandelstam analyticity is considered. The problem of the correct boundary of the spectral function for the scattering of scalar and pseudoscalar particles and a consistent procedure for the removal of multifold poles appearing on daughter levels are investigated. Ambiguities arising in the construction of the model are also discussed. (auth)

7910 FUNCTIONAL INTEGRAL REPRESENTATION FOR THE GREEN'S FUNCTION OF THE DUAL RESONANCE MODEL. Kobayashi, Tsunehiro; Shibasaki, Ichiro (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 3, 968-83(Sep 1971).

Functional integral method for the renormalization of the dual resonance model is proposed. The Green's function of the dual resonance model is represented in the functional integral form. It is also shown that the free propagator, one loop function, two-loop one and so on which have been obtained in the dual resonance model can be derived from the expansion of the Green's function in power series of the coupling constant. Renormalization problems for some characteristic diagrams are discussed. (auth)

7911 HADRONIC SCATTERING AMPLITUDES IN THE QUARK MODEL. II. INTRODUCTION OF SPINS OF QUARKS AND ANALYTIC PROPERTIES OF DUAL AND DIFFRACTIVE AMPLITUDES. Kobayashi, Tsunehiro (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 3, 938-67(Sep 1971).

Dual and Diffractive amplitudes are discussed in the unified description in terms of the quark model proposed in a previous paper (I). Introduction of spins and unitary spins of quarks and analytic properties of dual and diffractive amplitudes are investigated in meson–meson and meson–baryon scatterings. It is indicated that there are some possibilities for the analytic properties of the dual H type diagram, i.e., not only a pole-pole correspondence like the Veneziano amplitude but also a pole-cut correspondence and a cut-cut one. The Z type diagram in meson–baryon scattering is also studied and it is shown that the Z type diagram leads to only a pole-pole duality like the Veneziano amplitude except fixed cuts in the spin part of the amplitude. As for diffractive amplitudes, the generalized form of the Wu–Yang conjecture is derived. Baryon–antibaryon (baryon) scattering is also discussed. (auth)

7912 DUAL RESONANCE MODEL WITH REGGE CUTS. Yamagishi, Kenji (Waseda Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 46: No. 3, 835-45(Sep 1971).

A dual resonance model with Regge cuts is proposed and its phenomenological consequences are discussed. It may give enough theoretical framework for both high and low energy phenomenologies. It is shown that the total cross section can be determined from low energy parameters, if one assumes the existence of a diffractive term and interprets the Regge cut as a consequence of the absorption. (auth)

7913 ROLE OF FORM FACTORS IN HADRON RESONANCES. Mitra, A. N. (Univ. of Delhi). Ann. Phys. (N.Y.); 67: No. 2, 518-51(Oct 1971).

A phenomenological structure is proposed for the couplings of hadron resonances to the 56 baryons and 36 mesons with a view to exploring the possibilities of detailed dynamical applications of resonance data to several other areas of particle physics where these have relevance. The group structure used for hadron (H,H_L) classifications is that of SU(6) × O(3), while the basic framework for a unified description of the $\bar{H}PH_L$ and $\bar{H}VH_L$ interactions is provided by broken SU(3) × SU(3), or partial symmetry, in conjunction with the language (not dynamics) of the quark model. The coupling structures are expressed in terms of generalized Rarita–Schwinger fields and a Lorentz-invariant form factor (f_L) for whose construction a general set of criteria is proposed at the phenomenological level. One explicit construction of the form χ^L, satisfying the requirements of crossing symmetry and consistent with Regge universality of the reduced coupling constant (g_L) together with a common form of parametrization for $\bar{B}B_LM$ and MM_LM couplings, is obtained. The coupling structures not only account satisfactorily for several "difficult" branching ratios in baryon decays but also give (i) the observed "transverse" angular distribution in $B \rightarrow \omega\pi$ decay and (ii) a ratio $(h_1/h_0) \approx 0.57$ of the helicity amplitudes for $A_1 \rightarrow \rho\pi$ in rather good agreement with experiment. A PCAC relation between the $A_1\rho\pi$ and $\rho\pi\pi$ coupling constants which is derivable in a simple way within this framework is found to be in very good agreement with the value of the meson (L = 1) supermultiplet coupling constant $\bar{g}_1$ determined from the tensor meson decays. The mathematics of an explicit application of the model, viz., u-channel π^-–p scattering through the exchange of Δ-resonances in the spirit of the Van Hove model, is worked out in some detail to bring out the practical applicability of the model, especially in the intermediate energy region. Several other applications, viz., ranging from photo- and electroproduction of resonances to their effects on electromagnetic mass differences in hadrons, are discussed with special reference to the role of the form factor. (auth)

7914 TIME STRUCTURE OF HADRONS IN EXTENSIVE AIR SHOWERS AND MODELS OF HIGH ENERGY HADRON INTERACTIONS. Tonwar, S. C.; Sreekantan, B. V. (Tata Inst. of Fundamental Research, Bombay). J. Phys., A (London); 4: No. 6, 868-82(Nov 1971).

The arrival time spectra of hadrons of energy 5 to 40 GeV in extensive air showers of size 6.7×10^4 to 1.8×10^6 particles were obtained in an experiment carried out at Ootacamund (800 g cm^{-2} altitude) during 1968 to 69 and compared with the predictions from Monte Carlo calculations based on two different models, the "fireball" and "isobar-pionization" models, of high energy collisions. The "fireball" model predicts time spectra which are too steep compared to the observed ones. Variations within plausible limits of some of the parameters characterizing the hadron interactions like inelasticity, multiplicity, momentum distribution among secondaries and extent of nucleon–antinucleon ($N\bar{N}$) production do not succeed in reducing the discrepancy. The "isobar-pionization" model on the other hand succeeds well in explaining the observed features of the arrival time spectra when increased $N\bar{N}$ production is taken into account. Thus it is concluded that in high energy hadron collisions isobaric excitations of the interacting baryons play a very dominant role. The rapid increase in the cross section for the production of baryons in hadron collisions of energy greater than 10^{11} eV is also emphasized by this study. (auth)

7915 POMERON DOMINANCE AND INCLUSIVE MULTI-PARTICLE CROSS-SECTIONS. Le Bellac, M. (Univ., Nice). Phys. Lett.; 37B: No. 4, 413-15(13 Dec 1971).

It is shown that it is not possible to assume that both the N-particle inclusive cross sections and the two-body elastic cross section are dominated by the exchange of an isolated, factorizable Pomeron. (auth)

7916 POISSON DISTRIBUTION AND MULTIPERIPHERALISM. Caneschi, Luca (Stanford Univ., Calif.). Nucl. Phys.; B35: No. 2, 406-12(1971).

The asymptotic behavior of the production cross sections and the particle distributions are related to the J-plane structure of the forward elastic amplitude in a general multiperipheral framework. The validity of the Poisson distribution is investigated, and it is suggested that certain sums over production cross sections can be of particular physical relevance. (auth)

7917 CLASSIFICATION OF THE ONE-LOOP DIAGRAMS OF THE DUAL-RESONANCE MODEL. Takaya, Yoshimasa (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 4, 1178-91(Oct 1971).

It is shown by some examples that the integral corresponding to any one of the integral corresponding to any one of the one-loop diagrams of the dual-resonance model which are connected by the duality transformation is the same, when their integral regions are taken into account. Extending this conclusion to the case of the general N-point one-loop diagrams, the number of the independent diagrams which are never connected by the duality transformations are counted. (auth)

7918 DIP–BUMP STRUCTURE OF HADRON LARGE ANGLE SCATTERING IN TERMS OF MULTIPLE SCATTERING MECHANISM AND THE SPIN CORRELATION PARAMETERS. Wakaizumi, Seiichi (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 4, 1125–49(Oct 1971).

Large angle scattering of elementary particles is assumed to occur through the multiple scattering mechanism of composite particles. Here the quark model is taken and Regge poles are exchanged between quarks. Then, the double scattering of quarks leads to Regge-cut like energy dependence. The quark–quark scattering amplitude has the form of $a_R s^{\alpha(t)}$ and the quark-antiquark scattering amplitude has $a_R e^{-i\pi\alpha(t)} s^{\alpha(t)}$, except for pomeron exchange, under the assumption of exchange degeneracy of residues and trajectories of Regge poles exchange between quarks. The difference of phase between these two amplitudes and the multiple scattering mechanism results in the break and the dip-bump structure of differential cross sections for processes pp → pp, $K^+p \to K^+p$, $K^+n \to K^0p$, etc., and $\bar{p}p \to \bar{p}p$, $\pi^{\pm}p \to \pi^{\pm}p$, $\pi^-p \to \pi^0n$, $K^-p \to K^-p$, etc., respectively. Since the dip-bump structure of differential cross sections is sensitively determined from the phase behavior of scattering amplitude in the model, the validity of this model is tested by measurements of sensitively phase-dependent quantities such as spin rotation parameters R and A for $\pi^{\pm}p$ elastic scattering and spin correlation parameters D, R, A, A_{xx}, A_{yy}, A_{zz} , A_{zx}, etc., for pp elastic scattering. Here, these parameters are evaluated in the model and measurements of these parameters are proposed. It is shown that these parameters have peculiar behavior in the range of momentum transfers where the dip or break occurs in differential cross sections. Finally, relations between the multiple scattering mechanism of composite particles and the origin of resonance formation in the direct channel are discussed briefly. (auth)

7919 GENERAL REGGEON VERTEX IN DUAL THEORY. Yoneya, Tamiaki (Hokkaido Univ., Sapporo). Progr. Theor. Phys. (Kyoto); 46: No. 4, 1192-1206(Oct 1971).

On the basis of Fubini and Veneziano's manifestly dual symmetric operator expression for a dual amplitude, multiple-factorization of dual amplitude is performed in Shapiro's general factorization scheme. In contrast with other works, the method of multiple-factorization is completely symmetric with respect to Reggeon legs. A new general form of Reggeon vertex is obtained, which includes Lovelace's vertex as a particular limiting case, and Olive's one as a special case. Our general Reggeon vertex has simple gauge and twisting transformation properties. The duality relation is satisfied with the KSV change of propagator variables, as an identity of integrands. (auth)

7920 GENERALIZED TRANSFORMATION FUNCTIONAL OF A CONTINUUM MODEL OF THE DUAL AMPLITUDE. Shirafuji, Takeshi (Saitama Univ., Urawa, Japan). Progr. Theor. Phys. (Kyoto); 46: No. 4, 1218–47(Oct 1971).

An attempt is made to clarify the space-time picture of the functional integral formulation of the duality theory. It is shown that the functional underlying in this formulation can be considered as Dirac's generalized transformation functional (g.t.f.) of the position operator of an elastic string. The g.t.f. can be introduced only in the Euclidean metric theory. Several postulates are imposed on it. A functional differential equation of the g.t.f. is obtained. A manifestly crossing symmetric coupling scheme of the string with external sources is set up on the basis of the g.t.f. in the Euclidean framework; physical amplitude is obtained by analytic continuation with respect to the external momenta from the Euclidean region to the Minkowskian region. A few elementary consequences for the scattering amplitude in this scheme are obtained. (auth)

7921 RESULTS OF EIGHT-YEAR BRAZILIAN–JAPANESE COLLABORATION. Lattes, C. M. G. (Univ. de Campinas, Sao Paulo, Brazil). pp 600-18 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. III. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708–(Vol.3).

A discussion and data are given for the existence of fireballs. (J.F.P.)

7922 MAXIMUM LORENTZ FACTOR OF FIREBALLS. Tati, Takao (Univ. Campinas, Sao Paulo, Brazil). pp 757-61 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. III. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708–(Vol.3).

The hadronic phenomena are described by a basic field with a nonlinear coupling. An essential assumption is the cut-off of momentum degree of freedom of the basic particle which refers to a universal vector. The ground state of "hadronic matter" is obtained by solving the Schroedinger equation under simplified conditions. It is a cloud of a number of basic particles and their anti-particles, and is considered to give a hadron core. The excited states of hadronic matter are inferred correspondence-theoretically by using a Fermi-gas model and by referring to experimental facts. Hadron resonances and fireballs are considered to be different modes of excitation of hadronic matter. The picture allows one to have a quantum of some hundred MeV for resonances and H-quantum (constant-mass-fireball) of a few GeV. The three parameters reflecting the basic assumptions, the mass M, the coupling constant 1 and the cut-off length Λ, are interrelated in the theory and only one parameter remains free without changing the picture. Due to the cut-off referring to the universal vector, the Lorentz factor $\gamma = (1 - \beta^2)^-$ of hadronic matter can not exceed a certain value γ_{max}, if one takes a straight cut-off. For $\Lambda = 10^{-15}$ cm and $\Lambda = 10^{-16}$ cm, γ_{max} turns out to be 3.10^5 and 3.10^9, respectively. Though the cut-off may have a tail, the production probability of a matter with $\gamma > \gamma_{max}$ is expected to be small and the existence of a "giant" fireball seems probable. (auth)

7923 HIGH-ENERGY INTERACTION MODELS AND log tg($\theta^*/2$) DISTRIBUTION. Crino, E.; Miguel, O.; Fasulo, A.; Zgrablich, G. (Univ. Nacional de Cuyo, San Luis, Argentina). pp 775-88 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. III. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.3).

Some models of high energy interactions, and especially the two temperature model, are discussed in the light of the angular log tg($\theta^*/2$) distribution. Their connection with the existence of fireballs is also analyzed. (auth)

7924 INFINITE FIREBALL MODELS OF HIGH-ENERGY INTERACTIONS AND THEIR log tg(θ^*) DISTRIBUTION. Crino, E.; Miguel, O.; Zgrablich, G. (Univ. Nacional de Cuyo, San Luis, Argentina). pp 804-12 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. III. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.3).

The angular, log tg(θ^*), distribution for infinite fireball models, and in particular for Hagedorn's thermodynamical model, is discussed. (auth)

7925 RE-ASSESSMENT OF QUARK FLUXES. Bosia, G. (Univ., Turin. CNR, Turin); Briatore, L.; Sitte, K. pp 813-30 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. III. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708-(Vol.3).

The efficiency of quark detection in a telescope experiment is studied with the aid of two models of quark production embodying assumptions of rather extreme energy transfer conditions. These models are quite arbitrary, and the merely indicative results obtained, though unlikely to offer any accurate description of the true situation, are nevertheless believed to be useful in that they strongly suggest that the upper flux limits (of about 10 to the minus 10th power particles per sq cm per steradian per sec), usually determining the selection of possible quark events in telescope experiments, are not well founded. (auth)

Strong (Baryon No. = 0)

7926 (COO-1764-143) RESONANCE PHYSICS AT VERY HIGH ENERGIES. Rosner, Jonathan L. (Brookhaven National Lab., Upton, N. Y.). 8 Sep 1971. 38p. Dep. NTIS.

The following topics are discussed: diffraction, rarer final states, photon-photon processes, pionization, massive lepton pair production, and possible new types of resonances. (auth)

7927 POMERON: A FIXED CUT OF CHANGING CHARACTER? Kaiser, G. D. (Univ. of Durham, Eng.). Phys. Lett.; 37B: No. 3, 308-11(29 Nov 1971).

It is suggested that the Pomeron may be a fixed cut in the j-plane with t-dependent discontinuity. A simple parametrization incorporating P′ and ω Regge poles provides a good fit to the slope data for $|t| < 0.16$ (GeV/c)^2 in the momentum range 10 GeV/c $\leq P_{lab} \leq$ 1500 GeV/c: fits to total cross-sections are also satisfactory. (auth)

7928 RELATIVISTIC PARAMETRIZATION OF THE RHO MESON. Tschang, Yin-po; Parkinson, M. (Univ. of Florida, Gainesville). Nucl. Phys.; B35: No. 1, 262-8(1971).

A relativistic generalization of the Breit–Wigner formula is improved and applied to the ρ-meson. A good fit involving only one intrinsically free parameter is obtained. The new parametrization reduces to a simple Breit–Wigner form in the neighborhood of a resonance, but, as shown in the example of the ρ-meson, it is a better representation of the scattering amplitude in that it is accurate at energies far away from the resonance. (auth)

7929 ISOLATION OF RESONANCES IN HIGH MULTIPLICITY PROCESSES. Clayton, J.; Mason, P.; Muirhead, H.; Waldren, D.; Whiteley, K. (Univ. of Liverpool). Nucl. Phys.; B35: No. 1, 237-61(1971).

Techniques were examined for searching for resonances in high multiplicity processes. Two approaches based on the general features of the matrix elements for production and decay are described. The methods are used in conjunction with data on pp annihilation at 2.5 GeV/c. (auth)

7930 EXCHANGE-DEGENERACY AND ABSORPTION IN $\bar{p}p \to \bar{Y}Y$. Plaut, Guy (Univ., Nice). Nucl. Phys.; B35: No. 1, 221-33 (1971).

A study is made of $\bar{\Lambda}\Lambda$, $\bar{\Lambda}\Sigma^0$ + cc, and $\bar{\Sigma}^0\Sigma^0$ production in $\bar{p}p$ scattering with the help of absorbed K*–K** Regge pole model with exchange degeneracy. It is shown that the model fits rather well the cross sections and the polarization data in $\bar{p}p \to \bar{\Lambda}\Lambda$. A reliable measurement of polarization correlation coefficients should provide a crucial test of the model. (auth)

7931 LOW-ENERGY ZEROS AND REGGE POLES FROM AN EXTENDED AMATI–BERTOCCHI–FUBINI–STANGHELLINI–TONIN MULTIPERIPHERAL MODEL. Balazs, Louis A. P. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 4: No. 5, 1117-29(1 Sep 1971).

By inserting the elastic absorptive part from a multiperipheral model into a fixed-momentum-transfer dispersion relation, it is possible to obtain the low-energy amplitude in the crossed channel. The ABFST (Amati-Bertocchi-Fubini-Stanghellini-Tonin) version of this model is used so that the amplitude satisfies a BS (Bethe-Salpeter) equation. The Veneziano model for the ππ amplitude is used to calculate the ABFST input kernel, for which off-shell effects are neglected. The formalism goes beyond the usual pion-exchange dominance of the ABFST model by including an "inelasticity" factor in the BS equation. The strength of this factor is fixed by requiring that the Chew-Mandelstam ππ symmetry-point crossing condition is satisfied. It is then found that zeros arise in the S-wave amplitudes, which can presumably be identified with the zeros which are predicted from the Adler self-consistency condition. As a by-product, the leading Regge trajectories are calculated in our model. These have no difficulty in rising to fairly high angular momenta and lead to relatively narrow reduced widths for the ρ and f^0 resonances, as well as a high-energy total cross section in approximate agreement with experiment. (auth)

7932 LOW-LYING EXOTIC MESON TRAJECTORIES AND PROCESSES $p\bar{p} \to Y\bar{Y}$. Ghoroku, Kazuo; Myozyo, Yasuo; Noda, Hujio (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 46: No. 3, 820-34(Sep 1971).

Reactions which take place through the exchange of exotic quantum numbers, are investigated by taking account of the urbaryon rearrangement diagrams behind them and are classified into two classes. It is pointed out that these two classes are subject to different dynamical mechanism. The processes belonging to the first class are understood by the exotic meson exchange mechanism. The process $p\bar{p} \to Y\bar{Y}$ is analyzed by introducing the exotic mesons based on the urbaryon rearrangement diagrams, and their dynamical properties are investigated. It is found that the exotic mesons strongly couple to nucleon-antihyperon ($g_E \simeq 1.2g$) and lie on low-lying trajectories with the intercept $\alpha_E(0) \simeq -1.25$, whose slope ($\alpha_E' \simeq 0.45$) is flatter than the one of ordinary meson trajectories. (auth)

7933 NEW FORM OF DUALITY. Eguchi, Tohru; Igi, Keiji (Tokyo Univ.). Phys. Rev. Lett.; 27: No. 19, 1319-22(8 Nov 1971).

A new kind of finite-energy sum rule is proposed that new dual amplitudes must satisfy in addition to the usual finite-energy sum rules. This new form of duality is suggested by general considerations on the common properties of the Regge-behaved dual models. Some phenomenological implications of this new concept are briefly discussed. (auth)

7934 DUAL MODEL FOR MESON–BARYON SCATTERING WITHOUT PARITY DOUBLETS. White, J. N. J. (Daresbury Nuclear Physics Lab., Eng.); Zia, R. K. P. Nuovo Cim.; 6A: No. 2, 203-12(21 Nov 1971).

A dual model for meson-baryon scattering is considered in which the parity partners of the leading baryons are eliminated. The first resonance on the negative-normality leading trajectory has spin $^3/_2$. The model includes the duality constraints, does not decouple for backward scattering and gives acceptable elastic widths for the baryons. (auth)

7935 DIRECT-CHANNEL ANALYSIS OF THE PREDICTIONS OF A CROSSED-CHANNEL THEORY. Guo, T. C.; Horwitz, L. P. (Univ. of Denver). Nuovo Cim.; 6A: No. 2, 213-31(21 Nov 1971).

The total cross sections of various MM, MB, BB, and $B\bar{B}$ processes calculated by Horwitz and Rosner using the CHKN fit are expanded in terms of the imaginary parts of the forward elastic direct-channel amplitudes with SU_3 Clebsch–Gordan coefficients. It is consistent to assume that the energy-dependent parts of the amplitudes are SU_3 invariant, while the SU_3 violating parts are essentially constant background contributions. The changes of the s-channel amplitudes in energy are calculated; the results are consistent with what would be expected from considerations of duality. (auth)

7936 THEORY OF πK SCATTERING NEAR THRESHOLD. Johnson, R. C. (Durham Univ., Eng.). J. Phys., A (London); 4: No. 6, 883-7(Nov 1971).

A simple theory is developed for the process $\pi K \rightarrow \pi K$ near threshold. It is similar to one recently proposed for $\pi\pi \rightarrow \pi\pi$, and rests on an assumption of smoothness of the scattering amplitudes as functions of the energy-momentum invariants. The Adler PCAC consistency condition is imposed, but instead of current commutators, rho-meson dominance on the mass shell is used to fix overall normalization. The two approaches are connected by the KSRF relation, but because this model depends on two parameters (mass, width) more information is obtained. Thus the model contains P and D waves, and gives improved scattering-length predictions. Comparison with results from crossing-symmetric Regge models suggests that these need important additional terms. (auth)

7937 REGGE TRAJECTORIES AND THE POMERON SLOPE IN THE ABFST MULTIPERIPHERAL MODEL. Silverman, Dennis; Ting, Peter D. (Univ. of California, San Diego, La Jolla). Nucl. Phys.; B35: No. 2, 445-65(1971).

The forward and non-forward Amati–Bertocchi–Fubini–Stanghellini–Tonin (ABFST) multiperipheral integral equations with pion exchange and resonance production are solved in a factorizable approximation to the kernel. The solution, which determines the Regge trajectories, is continuous at $t = 0$ and is analytically continued and studied for all t. In this pion exchange model, the slope of the pomeron trajectory at $t = 0$ is calculated and is found to have a crucial dependence on the pion mass. The $\pi\pi$ cross section is also calculated in this approximation. The behavior of the trajectories near threshold is shown to be the same as in potential theory. The $t \rightarrow \pm\infty$ limits of the solution are also analyzed. (auth)

7938 APPLICATION OF INVARIANT RENORMALIZATION TO THE NON-LINEAR CHIRAL INVARIANT PION LAGRANGIAN IN THE ONE-LOOP APPROXIMATION. Ecker, G.; Honerkamp, J. (CERN, Geneva). Nucl. Phys.; B35: No. 2, 481-92(1971).

The functional for the one-loop diagrams for the non-linear chiral invariant pion Lagrangian is calculated invariantly using methods strongly reminiscent of gauge-invariant renormalization techniques in QED. It is shown that the restrictions chiral invariance puts on the renormalization counterterms do not suffice to extract finite results from the one-loop diagrams. The problem of the Adler condition in the presence of a symmetry breaking mass term is considered. (auth)

7939 SIMPLE SOLVABLE NEUTRAL π–π MODEL. Brander, O. (CERN, Geneva). Nuovo Cim.; 6A: No. 3, 371-9(1 Dec 1971).

A simple solvable neutral model of π-π S-wave scattering is presented, which is approximately crossing symmetric in the sense that it satisfies all but one of the numerous rigorous constraints derived from analyticity, positivity and crossing. It can be considered a generalization of the neutral S-wave model of Efremov et al., which does not satisfy those constraints. (auth)

7940 ROSKIES' CROSSING RELATIONS AND A DYNAMICAL CALCULATION OF PION–PION PHASE SHIFTS. Chung, K. P. (Princeton Univ., N. J.). Nuovo Cim.; 6A: No. 3, 289-303(1 Dec 1971).

The implications of Roskies' crossing equations for dynamical-model calculations are discussed with a comparison to the conventional differential forms of the crossing-symmetry relations of Chew and Mandelstam. Also, low-energy pion-pion phase shifts for S and P waves are calculated by means of Roskies' crossing constraints on the basis of general principles such as analyticity, unitarity and crossing symmetry. The dynamical computations yield the broad sigma-resonance near 930 MeV and the optimal solution corresponds to the scattering lengths $a_0 = 0.35$ and $a_2 = -0.078$. (auth)

7941 CHIRALITY IN DUAL-RESONANCE MODELS. Neveu, A. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France); Thorn, C. B. Phys. Rev. Lett.; 27: No. 25, 1758-61(20 Dec 1971).

A dual-resonance model for N pions which satisfies the Adler self-consistency condition and provides a generalization of the Lovelace–Shapiro formula for four pions is presented. The model has difficulty with SU(3) since there is no candidate for the ω degenerate with the ρ. Also the problem of extending the model to include fermions is briefly discussed. (auth)

7942 ONE-TERM VENEZIANO MODEL AND UNITARITY SUM RULE FOR πK SCATTERING. Ahmed, K.; Murtaza, G. (Univ. of Islamabad, Rawalpindi, Pakistan). Progr. Theor. Phys. (Kyoto); 46: No. 4, 1207-17(Oct 1971).

Igi and Storrow's proposal of using Veneziano model for $\pi\pi$-scattering in the unitarity sum rule of Arbab and Slansky is extended to πK-scattering. An attempt is made to solve the resulting non-linear sum rule in λ. (auth)

7943 CROSSING SYMMETRY CONSTRAINTS ON LOW ENERGY $\pi\pi$ SCATTERING. Krinsky, Samuel. New Haven; Yale Univ. (1971). 121p. University Microfilms Order No. 71-28,189.

Thesis.

The sum rules of Roskies are used to introduce constraints following from crossing symmetry into Brown and Goble's model of low energy $\pi\pi$ scattering. The S and P waves are parametrized in a way consistent with elastic unitarity, analyticity and current algebra. The Brown and Goble's P-wave is not modified, which is in agreement with experiment. There are five crossing symmetry sum rules relating the S and P waves. These are used to determine the parameters which are introduced into the S waves. Motivated by the smoothness assumption of PCAC, an approximate solution to the sum rules is found. The resulting S-waves are consistent with the present phenomenology of $\pi\pi$ scattering, with Martin's inequalities, and with the Adler sum rule. Also a family of exact solutions to the crossing symmetry sum rules is studied. It is shown that one does not need a complicated parametrization of the partial waves to satisfy elastic unitarity and Roskies' sum rules. Also, once the sum rules are satisfied, there is a tendency for many of Martin's inequalities to be satisifed. (Diss. Abstr. Int., B)

Strong (Baryon No. = 1)

Refer also to abstracts 7822 and 8365.

7944 (ITEF–815) CALCULATION OF KN AND $\bar{K}$N FORWARD SCATTERING AMPLITUDES FROM DISPERSION RELATIONS FOR BREAKDOWN OF THE POMERANCHUK THEORY. Vishnevskii, M. E.; Galanina, N. D.; Nikolaev, N. N.; Shistilin, V. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1970. 27p. (In Russian). Dep. NTIS (U. S. Sales Only).

The real parts of K ± N scattering amplitudes are calculated from dispersion relations and experimental total cross sections for the range of momentum from 0.6 to 60 GeV/c. The different assumptions are made for the asymptotics of the total cross sections. The regeneration amplitude and phase for K^0 mesons and K ± N charge exchange amplitudes are determined. In the framework of an optical model the regeneration amplitude on nuclei of copper and carbon are calculated. (auth)

7945 (ORO–3992–40) LINEAR TRAJECTORY FITS OF PION–NUCLEON SCATTERING AT HIGH ENERGIES. Gleiser, R. J.; Gleeson, A. M. (Texas Univ., Austin. Center for Particle Theory). Nov 1971. 71p. (CPT–124). Dep. NTIS.

A simple Regge model is investigated for high energy pion nucleon scattering. The trajectory parameters of this model are completely determined by the spins and masses of the particles lying on them. The necessity for bending the trajectories in order to reproduce the observed high energy dependence of the differential cross sections is avoided by not assuming that the continued partial wave amplitudes satisfy Mandelstam symmetry. The absence of this symmetry gives rise to extra terms in the asymptotic form of a given amplitude. These extra terms are unambiguously determined by the model, and do not require further parametrization or physical interpretation. An explicit example is given showing that in relativistic scattering, Mandelstam symmetry is not a necessary consequence of the Froissart–Gribov representation. This model is tested by fitting all the available high-energy pion nucleon scattering data with experiment. An extended version of this model predicts, for forward pion nucleon charge-exchange scattering, a nonzero polarization with only rho exchange. (auth)

7946 PROTON–NEUTRON MASS DIFFERENCE IN SUDARSHAN'S THEORY OF UNIVERSAL PRIMARY INTERACTIONS. Acharya, R. (Duke Univ., Durham, N. C.); Aly, H. H.; Schilcher, K. Int. J. Theor. Phys.; 4: No. 6, 477-81(Oct 1971).

The neutron–proton mass difference in Sudarshan's universal theory of primary interactions was computed by appealing to the Feynman–Speisman prescription. It is predicted that the correct sign with $\delta M_p - \delta M_n \approx -0.6$ MeV. (auth)

7947 TWO-BODY WEAK REACTIONS OF HADRONS AT VERY HIGH ENERGIES. Dubovoy, Mark; Langacker, Paul; Suzuki, Mahiko (Univ. of California, Berkeley). Phys. Rev., D; 4: No. 5, 1474-85(1 Sep 1971).

Two-body hadronic scattering through weak interactions is investigated theoretically in the energy region accessible at the National Accelerator Laboratory. In the ordinary current × current form of weak interactions, the following quantities are calculated for charge-exchange weak hadronic reactions: (i) the differential cross section, the polarization of a final baryon, and the asymmetry in the angular distribution of scattering from a polarized target for strangeness-changing processes, and (ii) the interference of weak-interaction amplitudes with strong-interaction amplitudes for processes to which both weak and strong interactions contribute. The interference with strong amplitudes is discussed by means of a straight extrapolation of existing Regge analysis at lower energies (less than 30 GeV). Differential cross sections near the forward direction are typically of the order of 10^{-38} cm^2 in $d\sigma/d\cos\theta$ in the center-of-mass frame. The interference between weak and strong amplitudes is unfortunately only one part in 10^4 to 10^5 for the πN charge-exchange scattering in spite of the different high-energy behavior. All calculations are supposed to be valid at high energies up to absorption corrections due to a Regge cut generated by the Pomeranchukon and a fixed pole at J = 1 from the weak amplitude. Inelastic scattering is also briefly mentioned. Charge-nonexchange processes are discussed in connection with a test for the existence of neutral weak currents. (auth)

7948 π^+P ELASTIC SCATTERING AND IMPACT PARAMETER. Hayashi, Hirofumi (Shizuoka Univ., Japan); Kaiba, Masayuki; Murayama, Akihiro; Yoneyama, Tohru. Progr. Theor. Phys. (Kyoto); 46: No. 3, 992-4(Sep 1971).

Data on hadron interactions at high energies were analyzed and it was found that the observed baryon resonances are grouped together in three sets by the impact parameters, i.e., about 1 fm, 0.6 fm, and 0.4 fm. This result is used to reproduce the π^+p elastic scattering differential cross section at 5.0 GeV/c. (L.B.S.)

7949 REMARK ON BARYON WIDTHS. Lee, Chien-er (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 4: No. 5, 1565-6(1 Sep 1971).

The approximation in which the high partial waves are ignored in the decay of baryons with arbitrary spins is compared with the usual approximation which consists only of the decay amplitude associated with the minimum number of momenta. The discrepancy between these two approximations increases as the mass and the spin of the decaying baryon increase, but is generally small compared with the experimental uncertainties of the decay widths. (auth)

7950 POSSIBLE METHOD OF TESTING THE UNIVERSALITY OF STRONG INTERACTIONS. Baldin, A. M.; Suleymanov, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett.; 37B: No. 3, 305-7(29 Nov 1971).

It is shown that the cross section of the process $\pi^- + p \rightarrow n + e^+ + e^-$ at the effective mass e^+e^--system $m^2 \lesssim m_\pi^2$ has the same order of magnitude as at $m^2 = m_\rho^2$ and is very sensitive to the universality relation of coupling constants of vector mesons. (auth)

7951 MODEL FOR DIFFRACTIVE PROCESSES. Ravndal, F. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Lett.; 37B: No. 3, 300-4(29 Nov 1971).

A unified description of diffractive processes is obtained by assuming a factorizable vector current × vector current form for the imaginary amplitude, the vector current being a conserved, SU(3) singlet transition operator. Taking the current matrix elements from a relativistic quark model, good agreement with experiment is found in most cases considered. (auth)

7952 Δ_δ REGGE TRAJECTORY AND NONDEGENERATE PARITY PARTNERS. Sivers, Dennis (Argonne National Lab., Ill.). Phys. Rev., D; 4: No. 5, 1444-51(1 Sep 1971).

The hypothesis that the D(1670) is the MacDowell partner of the Δ(1234) is presented. This idea predicts a G_{37} πN resonance with mass 2530 MeV, and implies that for fixed, nonzero u, the sign of the π^-p polarization should change with increasing s. (auth)

7953 DECISIVE TESTS FOR DIP MECHANISMS. Tran Thanh Van, J. (Universite Paris, Orsay, France). Phys. Rev., D; 4: No. 5, 1571-3(1 Sep 1971).

Some decisive tests for dip mechanisms are proposed: measurements of density-matrix elements of $\pi^+n \rightarrow \omega p$ and $\pi^+p \rightarrow \omega\Delta^{++}$, and forward behavior of differential cross section of η production. Available data seem to be in disagreement with the simple Dar-Michigan picture, and in favor of the weak-cut model. (auth)

7954 t-CHANNEL HELICITY CONSERVATION AND THE DECK EFFECT. Donohue, J. T. (Univ., Nice). Nucl. Phys.; B35: No. 1, 213-20(1971).

The experimentally observed conservation of t-channel helicity in A_1 and Q production can be interpreted in terms of the Reggeized Deck effect. The dynamical assumptions that the pion exchange diagram is dominant and that the low mass $\rho\pi$ or $K^*\pi$ states are mainly S-wave suffice to show ρ_{00} for the A_1(Q) should be approximately equal to ρ_{00} for the ρ or K^*, when both are measured relative to the t-channel axes. If pion exchange is important one expects $\rho_{00} \simeq 1$ for the ρ and K^* and the observed results for the A_1 and Q follow as kinematical consequences. The argument depends neither on the nature of the pomeron coupling nor on the existence of the A_1 as a particle. (auth)

7955 A_2 DOUBLE PEAKING AS SELF-ABSORPTION. Peaslee, D. C. (Australian National Univ., Canberra). Phys. Rev., D; 4: No. 5, 1375-8(1 Sep 1971).

Double peaking of the A_2 meson at 1300 MeV is interpreted as self-absorption of a single peak in the production process $\pi + p \rightarrow p + A_2$. A central dip appears only if the absorption parameter exceeds a certain minimum; otherwise the peak is simply broadened. A possible second instance of peak splitting is pointed out in the ($K\pi$) resonances between 1000 and 1300 MeV. The vector mesons do not seem to show much self-absorption, however, and the question of how to predict this effect remains unanswered, except for the qualitative statement that strongly coupled resonances are weakly self-absorbed and vice versa. Strong absorption or final-state interaction effects are nonlinear and when present may preclude compilation of data from different boson production processes. (auth)

7956 DIRECT-CHANNEL DESCRIPTION OF THE REACTIONS $\pi^-p \rightarrow \eta n$ and $\pi^-p \rightarrow \pi^0 n$ AT HIGH ENERGY. Danburg, Jerome S. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 4: No. 5, 1325-35(1 Sep 1971).

Amplitudes made up only of direct-channel resonance contributions are constructed in accordance with a simple model to fit the high-energy data for the reactions $\pi^-p \rightarrow \eta n$ and $\pi^-p \rightarrow \pi^0 n$. A good fit is obtained for the differential cross section, total cross section, and the (sparse) polarization data at high energy for $\pi^-p \rightarrow \eta n$. For the charge-exchange reaction, the fits to the total cross section, the polarization, and the forward peak of the differential cross section are satisfactory; a simple extension of the model is shown to account in a rough way for the secondary peak in the differential cross section and its disappearance with increasing energy. (auth)

7957 ASSIGNMENTS OF Y_1^* RESONANCES TO SU(3) MULTIPLETS. Islam, G. S. (Univ. of Rajshahi, East Pakistan). J. Natur. Sci. Math.; 10: No. 2, 191-7(Oct 1970).

Relative phases of a few Y_1^* states were measured from a partial wave analysis of the reaction $\overline{K}n \rightarrow \overline{\pi}\Omega$ in the center-of-mass energy region 1850 to 2160 MeV. SU(3) assignments of the resonances seen or confirmed in this energy interval were made tentatively on the basis of their relative phases at resonance. (auth)

7958 EXOTIC EXCHANGE FOR INCLUSIVE REACTIONS AND FOR QUASI-TWO-BODY PROCESSES. Ko, Winston; Lander, Richard L.; Risk, Clifford (Univ. of California, Davis). Contract AT(04-3)-34. Phys. Rev. Lett.; 27: No. 21, 1476-8(22 Nov 1971).

The reaction $K^+ + p \rightarrow \pi^- +$ anything with the π^- fast and forward is analyzed with a peripheral representation that allows one to extract the two-body exotic-exchange amplitude with high statistics that are otherwise hard to come by. By representing the inclusive spectrum in a Reggeized scaled form, the energy dependence of the two-body reactions $\pi^- + p \rightarrow K^+ + \Sigma^-$ and $\pi^- + p \rightarrow K^+ + Y^{*-}(1385)$ is predicted—the results are in good agreement with the experimentally measured data. (auth)

7959 ALEPH-PARTICLE. Fujimoto, Yoichi; Sugimoto, Hisahiko (Waseda Univ., Tokyo). Progr. Theor. Phys. (Kyoto), Suppl.; No. 47, 30-2(1971).

Successive nuclear interactions in an emulsion chamber experiment were analyzed to see whether observational data are consistent with predictions of Koshiba aleph-particle theory. According to this theory, the fireballs observed in the emulsion chambers are to be identified as η' meson produced in the decay aleph particle $\rightarrow$ nucleon + η'-meson + Q(117 MeV), and that the observation picks up only those events which correspond to the decay mode η'-meson $\rightarrow$ several π^0-meson + γ-rays + no $\pi^\pm$-meson, according to some selection bias. The experimental values of $m_{\eta'}$, $P_{T\eta'}$, and M_{aleph} are found to be in disagreement with the expected values of Koshiba's theory. (L.B.S.)

7960 ZEROLOGY OF KAON–NUCLEON AMPLITUDES AND KNY COUPLING CONSTANTS. Zovko, N. (Inst. Rudjer Boskovic, Zagreb. Univ., Zagreb). Nuovo Cim.; 6A: No. 3, 304-18(1 Dec 1971).

Sum rules emerging from the conventional dispersion relations, phase dispersion relations and dispersion relations for the inverse amplitudes are studied in terms of kaon-nucleon forward scattering parameters. Solutions for ΛKN and ΣKN coupling constants and zeros in the complex ω-plane of both T^+ and T^- kaon-nucleon amplitudes are obtained. The consistency of these solutions is then tested by predictions for other both low- and high-energy scattering parameters. (auth)

7961 DISPERSION-THEORETICAL TREATMENT OF COULOMB CORRECTIONS TO LOW-ENERGY $\pi^-p \rightarrow \pi^-p$ AND $\pi^-p \rightarrow \pi^0 n$ SCATTERING. Sauter, E. (Kernforschungszentrum, Karlsruhe, Ger.). Nuovo Cim.; 6A: No. 3, 335-49(1 Dec 1971).

The S-matrix method of Dashen and Frautschi is used to calculate Coulomb corrections to the coupled-channel scattering processes $\pi^-p \rightarrow \pi^-p$ and $\pi^-p \rightarrow \pi^0n$. The agreement with the conventional treatment of Van Hove and Oades and Rasche is as good as in the one-channel problem $\pi^+p \rightarrow \pi^+p$. (auth)

7962 DETERMINATION OF HIGH ENERGY KN SCATTERING AMPLITUDES. Hayot, F.; Navelet, H. (CEN, Saclay, France) Phys. Lett.; 37B: No. 4, 424-6(13 Dec 1971).

With assumptions about the remaining amplitudes, $M_{++}^{I=0}$, the s channel helicity non flip amplitude of isospin zero in the t channel, is extracted from data on K^-p elastic and charge exchange scattering at 10 GeV/c. It is found that Im $M_{++}^{I=0}$ without the Pomeron contribution is strongly absorbed, whereas Real $M_{++}^{I=0}$ seems to be pure Regge type. (auth)

7963 DUAL ABSORPTIVE MODEL AND UNITARITY. Zarmi, Y. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Lett.; 37B: No. 4, 393-6(13 Dec 1971).

The unitarity content of amplitudes whose parameter profile is peripheral is shown to be dominated by contributions of inelastic intermediate states. This explains the approximate equality of elastic cross sections for ab → ab and $\bar{a}b \rightarrow \bar{a}b$ at rather low energies. (auth)

7964 CORRELATION BETWEEN THE LEADING-PARTICLE DISTRIBUTIONS IN pip AND pp COLLISIONS. Hwa, R. C. (Univ. of Oregon, Eugene). Contract AT(45-1)-2230. Phys. Lett.; 37B: No. 4, 405-7(13 Dec 1971).

The flatness of the leading-particle distributions in πp and pp collisions at large cm longitudinal momenta is explained in terms of single-excitation processes. Their heights are related to their total cross sections and a certain universality relation is shown to exist between the πp and pp processes. The relation is in agreement with the available experimental data. (auth)

7965 INCLUSIVE PION DISTRIBUTIONS AT PRESENT MACHINE ENERGY. Jacob, M.; Slansky, R. (Yale Univ., New Haven). Contract AT(30-1)-2726. Phys. Lett.; 37B: No. 4, 408-12(13 Dec 1971).

All the features of pion inclusive spectra observed in recent experiments can be reproduced in a model calculation which emphasizes the diffractive excitation of either the target or the projectile. There is practically no freedom in the choice of the model parameters. The model makes definite predictions about the approach to scaling and has direct implications about exclusive experiments. (auth)

7966 IMPLICATIONS OF FINITE ENERGY SUM RULES IN PION–HYPERON SCATTERING. Renner, B. (Univ., Hamburg); Zerwas, P. Nucl. Phys.; B35: No. 2, 397-405(1971).

Engels and Pilkuhn have proposed a possible I = 2 $(\Sigma\pi)$-resonance on the basis of questionable unsubtracted dispersion relations for the crossing-symmetric A amplitudes in $(\pi\Lambda)$- and $(\pi\Sigma)$-scattering, saturated by the known resonances and required to reproduce the Adler consistency conditions. In a search for alternative mechanisms to restore consistency without exotic states, finite energy sum rules are introduced instead of unsubtracted dispersion relations and the hypothesis that saturation is achieved by the exchanges of f and ϵ trajectories is examined. By comparing the resultant Regge residues with the high energy polarization data in $K^{\pm}P$ scattering, attributed to A_2-pomeron interference, the approximate magnitude of the required f contribution is confirmed by SU(3) and the ϵ-contribution is checked against the corresponding sum rule in the πN system. Approximate consistency of these tests eliminates the need for exotic resonances. (auth)

7967 ORIGIN OF ZEROS IN THE ρ-REGGE RESIDUES IN $\pi^-p \rightarrow \pi^0n$. Henzi, R. (McGill Univ., Montreal). Nucl. Phys.; B35: No. 2, 434-44(1971).

Zeros in the ρ-Regge pole residues in $\pi^-p \rightarrow \pi^0n$ are shown to result from a form factor effect in the s-channel. The form factor is associated with (weak) duality of the ρ-Regge pole. (auth)

7968 PREDICTIONS FOR ρ PRODUCTION FROM PION PHOTOPRODUCTION AND VECTOR MESON DOMINANCE. Kellett, B. H. (Univ. of Manchester, Eng.). Nucl. Phys.; B35: No. 2, 517-40(1971).

A covariant formulation of the vector meson dominance hypothesis in terms of invariant amplitudes is presented. It is shown that explicit continuation in the external vector mass of the kinematical coefficients relating the invariant and helicity amplitudes allows the prediction of $\pi^-p \rightarrow \rho^0n$ from charged pion photoproduction. Such predictions from a detailed fit to pion photoproduction, with the assumption that the extrapolation of the invariant amplitudes is free from dynamical dependence on the ρ mass, are shown to be in excellent agreement with the ρ^0 production data. (auth)

7969 VECTOR MESON PRODUCTION, PION PHOTOPRODUCTION AND VECTOR MESON DOMINANCE. Kellett, B. H. (Univ. of Manchester, Eng.). Nucl. Phys.; B35: No. 2, 541-55 (1971).

The vector meson dominance hypothesis can be formulated covariantly in terms of invariant amplitudes. This method, which has been successfully used to predict $\pi^-p \rightarrow \rho^0n$ from pion photoproduction, is extended to include ω production and charged ρ production. With the introduction of only two further parameters to describe the mass dependence of the $\rho\omega\pi$ coupling, a unified description of vector meson production and pion photoproduction is obtained. (auth)

7970 STUDY OF THE DISPERSION RELATIONS FOR FORWARD $K^{\pm}p$ SCATTERING. O'Brien, D. M. (Univ. of Adelaide); Woolcock, W. S. Nucl. Phys.; B35: No. 2, 613-30(1971).

Forward dispersion relations, indexed by continuous parameters β and ω_0, are written for the class of functions $B_{\pm}(\omega) = F_{\pm}(\omega)/(\omega \pm m_K)^{\beta}(\omega \pm \omega_0)^{1-\beta}$, $0 \leq \beta \leq 1$, $0 \leq \omega_0 \leq m_K$, defined in terms of the $K^{\pm}p$ forward scattering amplitudes $F_{\pm}$ in the laboratory system. The value of the integral involving F_- over the unphysical region of energies below the K^-p threshold is sensitively controlled by β and ω_0, so that this class of dispersion relations ought to provide a good test of the extrapolation of a model amplitude into the unphysical region. This method was used to test three models — a modified constant scattering length analysis, a zero-range K-matrix analysis and an effective-range K-matrix analysis — but the usefulness of the test is found to be limited by the very poor D_- data currently available. Some comments are made about the estimation of the strange particle coupling constants appearing in the dispersion relations. (auth)

7971 ZEROS OF PION–NUCLEON SCATTERING AMPLITUDES. Shafee, A. (Cavendish Lab., Cambridge, Eng.). Nucl. Phys.; B35: No. 2, 556-72(1971).

The locations of zeros of the pion-nucleon scattering amplitudes A'^+, A'^-, B^- and B^+ are calculated by means of dispersion relations from phase shift solutions and Regge parameters. The complex paths of zeros are traced and give evidence of the connections between zeros that perform different functions but lie on a common surface of zeros; these include: Legendre zeros associated with resonances, zeros that kill double poles, zeros that produce the crossover effect, residue zeros, and zeros that cause scattering lengths to be small. (auth)

7972 PERIPHERAL RESONANCE PRODUCTION VERSUS KINEMATICAL REFLECTION AND NON-DUAL PROPERTY OF A PION EXCHANGE. Kagiyama, Shigenori; Uehara, Masayiki (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 46: No. 4, 1096-1110(Oct 1971).

A one-pion-and-pomeron-exchange model is proposed for single pion production processes, where the one-pion exchange is assumed to be non-dual to the direct channel resonances just like the pomeron. According to this model the Drell – Hiida – Deck mechanism should be regarded as non-resonant background so that it can be added to the diffractive resonance production without any trouble of double counting. Studying the processes $\pi^-p \rightarrow \pi^-\pi^+n$ and $\pi^-p \rightarrow \pi^-\pi^0p$, it is shown that the model can reproduce the prominent features of the reactions and then the low mass enhancement of π^+n at 1.2 to 1.4 GeV is predominantly due to the Drell – Hiida – Deck effect and the $\pi\pi$ resonance contribution. The decay angular distributions of the ρ^0 and f^0 mesons, which are produced mainly by the one-pion exchange, are reasonably explained in terms of the effect of the kinematical reflection of the N* resonances. It is pointed out that such a kinematical reflection is important also in the processes without pomeron exchange. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 7521, 8134, and 8329.

7973 FURTHER EXPERIMENTAL TESTS OF SCALING IN THE PROCESS $pp \rightarrow \pi^- +$ ANYTHING. Michejda, L. (Inst. of Nuclear Research, Warsaw). Nucl. Phys.; B35: No. 1, 287-316 (1971).

The hypothesis of scaling in the c.m. longitudinal momentum for the single-particle distribution of pions is checked against various experimental data on inelastic pp reaction. The so-called structure function fitted by Bøggild, Hansen and Suk for the π^- produced in the process $pp \rightarrow \pi^- +$ anything at 19 GeV/c was used as an input. Its consequences are discussed for the prong multiplicity, the average transverse momentum and angular distributions for various energies, including both the accelerator and the cosmic-ray data. Crucial tests of the predicted infinitely developing peak at $p_L = 0$ for the scaled longitudinal momentum distribution $d\sigma/dx$ are discussed. Some evidence that narrowing of this peak with increasing energy is faster than expected from scaling is presented. (auth)

7974 EXISTENCE OF THE HYPERNUCLEUS Λ-^{8}He. Juric, M. (Inst. of Physics, Belgrade); Bohm, G.; Klabuhn, J.; (and others). Nucl. Phys.; B35: No. 1, 160-6(1971).

The existence of the hypernucleus $^8_\Lambda$He was established with the Λ-hyperon separation energy $B_\Lambda = 7.16 \pm 0.70$ MeV. (auth)

7975 FACTORIZATION TEST FOR ρ EXCHANGE. Alam, M. Anis; Bari, M. B.; Razmi, M. S. K. (Univ. of Tabriz, Iran). Phys. Rev., D; 4: No. 5, 1442-4(1 Sep 1971).

A direct test of factorization for ρ exchange is suggested and it is shown that it satisfies the available experimental data reasonably well. (auth)

7976 DOUBLE-REGGE-POLE ANALYSES OF $p + p \rightarrow p + \pi^- + \Delta^{++}$ AT 22 GeV/c. Coleman, T. P. (Ames Lab., Iowa. Trinity Coll., Dublin). Phys. Rev., D; 4: No. 5, 1382-91(1 Sep 1971).

The double-Regge-pole models of Berger, of Chan, Kajantie, and Ranft, and of Chan, Łoskiewicz, and Allison for the reaction $p + p \rightarrow p + \pi^- + \Delta^{++}$ are compared with data at 22 GeV/c. Kinematical cuts are made in the data to isolate a single amplitude involving only Pomeranchuk and pion trajectories. A moderate form of duality permits extrapolation of this amplitude down to threshold of the $\pi^-\Delta^{++}$ system, effectively enhancing the statistics of the data. The first model is reasonably consistent with the present data and with the best parameter values of earlier analyses. The second model describes the data almost as well as the first model, though the best parameter values differ from previous fits. The third model does not adequately describe the data. (auth)

7977 ELASTIC pd-SCATTERING AT HIGH ENERGIES. Kolybasov, V. M.; Smorodinskaya, N. Ya. (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Lett.; 37B: No. 3, 272-4(29 Nov 1971).

Elastic pd-scattering at large angles is considered in terms of a virtual pion exchange model. The theoretical results are compared with the experimental data at 1 GeV proton energy. (auth)

7978 PSEUDOSCALAR AND VECTOR-MESON MODELS FOR NUCLEON–NUCLEON SCATTERING OUTSIDE THE PHENOMENOLOGICAL CORE. Barker, Bruce M. (Louisiana State Univ., Baton Rouge); Haracz, Richard D. Phys. Rev., D; 4: No. 5, 1336-41(1 Sep 1971).

The one-pion-exchange (OPE), one- and two-pion-exchange (OPE + TPE), and pseudo-scalar-vector-meson-exchange (PV) models are described. The corresponding phase parameters are compared with the phenomenological phase parameters excluding the S-state parameters and the coupled D-state contribution. It is found that the OPE + TPE model is a definite improvement on the OPE model, and it provides a reasonably good fit to the phenomenological values for the D-state and higher-L contributions. The introduction of the η pseudoscalar resonance and the ω and ρ vector resonances in the PV model does not improve upon the fit to the $L \geq 2$ phases. However, the PV model improves upon both the OPE and OPE + TPE models in a comparison with the P-state phases, and it reduces the value of the pion-nucleon coupling constant. (auth)

7979 TEST OF PERIPHERALITY FOR N–N SCATTERING. Binstock, Judith (Texas A and M Univ., College Station); Bryan, Ronald. Phys. Rev., D; 4: No. 5, 1341-52(1 Sep 1971).

A semiquantitative test of peripherality in nucleon-nucleon scattering (up to 425 MeV lab kinetic energy) is carried out, using meson-nucleon coupling constants obtained from experiments other than nucleon-nucleon scattering. The model used is a pole model, plus a 2π-exchange contribution, with geometric unitarization. The results show that a series of exchanges of increasingly larger masses gives an increasingly better description of the middle Taketani region ($0.7\ F < r \leq 2\ F$). The series of exchanges considered is π exchange, $\pi + 2\pi$ exchange, and $\pi + 2\pi + \rho + \omega$ exchange. The exchange of $\pi + 2\pi + \rho + \omega + \epsilon(715)$ is also considered, and an estimate is derived for the coupling constant $g^2_{NN\epsilon}$, assuming a width of $\Gamma_\epsilon = 370$ MeV. (auth)

7980 Λ-NUCLEON CHARGE-SYMMETRY-BREAKING INTERACTION. I. SEPARABLE POTENTIALS. Hartt, K.; Sullivan, E. (Univ. of Rhode Island, Kingston). Phys. Rev., D; 4: No. 5, 1353-66(1 Sep 1971).

The existence of a charge-symmetry-breaking (CSB) term in the lambda-nucleon (Λ-N) interaction is shown to produce an admixture of a T = 1 state to the predominant isospin singlet state in $_\Lambda H^3$. The present analysis shows that a CSB term constructed to fit light hypernuclear and Λ-p scattering data is poorly determined (~4%–25% of the total Λ-p singlet and ~4%–15% of the total Λ-p triplet interaction), but is strongly correlated with the Λ-separation energy, B_Λ, from $_\Lambda H^3$, and that isospin mixing in $_\Lambda H^3$ can lead to significant adjustments of the deduced Λ-N interaction strengths. The mixed-symmetry T = 0 state in $_\Lambda H^3$ is seen to have a small effect. Data employed include Λ-p total cross sections, $\sigma(\Lambda p)$, for total cm energy $E_{cm} < 18$ MeV, published values of B_Λ, and a theoretical determination by Herndon and Tang of the relative magnitudes of the Λ-N potentials responsible for the mean binding and the ground-state splitting of $_\Lambda He^4$ and $_\Lambda H^4$. The two hypotheses that the spin, I, of $_\Lambda He^4$ is 0 and 1 are studied. Nonlocal separable, spin-dependent central interactions of the Yamaguchi form are used, and all range parameters in the Λ-N interaction are constrained to be equal. A search of fits to $\sigma(\Lambda p)$ is made with intrinsic ranges in the interval 1.5 F to 2.3 F. Self-consistent CSB potentials are found for I = 0 and I = 1. The deduced singlet Λ-p CSB interaction is attractive in all cases, in disagreement with predictions of the SU_3 particle-mixing model of Downs. (auth)

7981 Λ-NUCLEON CHARGE-SYMMETRY-BREAKING INTERACTION. II. RANK-2 POTENTIALS. Sullivan, E.; Hartt, K. (Univ. of Rhode Island, Kingston). Phys. Rev., D; 4: No. 5, 1366-74(1 Sep 1971).

A potential model of the Λ-N interaction containing short-range repulsions is constructed to study charge-symmetry-breaking (CSB). Rank-2 nonlocal central potentials and a rank-1 approximation to them (referred to as UPAA) are required to fit low-energy Λ-p scattering cross sections, the Λ-separation energy (B_Λ) from $_\Lambda H^3$, and a dimensionless parameter which partially characterizes the CSB part of the binding-energy difference between $_\Lambda H^4$ and $_\Lambda He^4$. In a scan of these data, a class of potentials with acceptable χ^2 fits is found. Repulsions are seen to reduce significantly the lower limits of the singlet and triplet CSB strengths required in the entire data scan, from the CSB found earlier without including repulsions. In particular, for the largest value of B_Λ used, 0.25 MeV, qualitative agreement with Downs's SU_3 model of CSB is attained, in that the Λ-p CSB singlet interaction can be repulsive. This conclusion also holds for the UPAA, with an indication that a short-range weakening of Λ-N attraction has an effect similar to a Λ-N repulsion. Effects of isospin mixing in $_\Lambda H^3$ are taken into account. The Λ-N potentials resulting from this analysis are seen to vary in a systematic way within the statistical spread of available data. (auth)

7982 NONLINEAR EQUATION FOR THE CORRELATION FUNCTION BETWEEN AN IMPURITY PARTICLE AND A NUCLEON IN NUCLEAR MATTER. Grypeos, M. E. (International Centre for Theoretical Physics, Trieste, Italy. Democritus Nuclear Research Center, Athens). Nuovo Cim.; 6A: No. 2, 245-58(21 Nov 1971).

A new approach is proposed for the determination of the correlation function between an impurity particle (for example a Λ-particle) and one of the particles of an infinite host medium of identical particles (taken to be the nuclear matter). By using an approximate expression in "closed form" for the trial energy of the Λ-particle in its ground state in nuclear matter and applying the variational principle in a suitable way, a nonlinear integro-differential equation for the Λ-nucleon correlation function is obtained. This equation is further reduced to a linear integro-differential equation by using a proper linearization procedure. It is finally shown that for large Λ-nucleon separations an effective (reduced) mass $\mu^*_{\Lambda N}$ for the Λ-nucleon pair can be defined. (auth)

7983 EFFECTIVE Λ–N INTERACTION. Hasan, Fawzia; Rahman, Khan, M. Z.; Usmani, Q. N. (Aligarh Muslim Univ., India). pp 647-50 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

7984 INSTRUCTIONAL USES OF THE COMPUTER: QUANTUM SCATTERING THEORY. Bardwell, Steven J. (Swarthmore Coll., Pa.). Amer. J. Phys.; 39: No. 12, 1534-5 (Dec 1971).

A computer program for the Born approximation for the differential cross sections for neutron scattering by a central screened Coulomb potential as a function of energy is used to generate plots for these cross sections. The program is written in FORTRAN IV for an IBM 1130. (J.F.P.)

7985 LIGHT CONE ANALYSIS OF HADRONIC INCLUSIVE REACTIONS. Segre, G. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Lett. Nuovo Cim.; 1: No. 26, 1085-90(26 Jun 1971).

A light cone analysis of the reaction $pp \rightarrow \pi^+ +$ hadrons is presented. It is shown that the expansion of the product of pion sources near the light cone has a leading behavior $\leq 1/x^2$. (L.B.S.)

7986 STRUCTURE OF THE INCLUSIVE PION SPECTRUM NEAR $\chi = 0$. Pignotti, A. (Brookhaven National Lab., Upton, N. Y. Univ. of Washington, Seattle); Ripa, P. Phys. Rev. Lett.; 27: No. 22, 1538-41(29 Nov 1971).

The behavior of the longitudinal pion spectrum for the process $pp \to \pi +$ anything is studied in the region of small values of $\chi = 2p_{||}^{c.m.}/s^{1/2}$ by using a simplified multiperipheral model. The occurrence of an inverted cusp in the spectrum at very large energies and the appearance of noticeable effects at the energies of the CERN intersecting storage rings is expected. (auth)

7987 EFFECTS OF THE COULOMB FIELD ON SCATTERING BY DEUTERIUM. Franco, Victor (City Univ. of New York, Brooklyn. Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett.; 27: No. 22, 1541-4(29 Nov 1971).

The Coulomb field is included in the analysis of scattering by deuterium via an exact solution within the framework of Glauber theory. New multiple-scattering effects occur. These involve double scatterings by the Coulomb interaction and the neutron and by the Coulomb interaction and the proton strong interaction, as well as triple scattering by the Coulomb interaction, the neutron, and the proton strong interaction. Coulomb effects in pp collisions are obtained as special case of pd scattering. (auth)

7988 NEW SET OF KINEMATIC VARIABLES. Pinsky, Stephen S. (Univ. of Utah, Salt Lake City. Argonne National Lab., Ill.). Phys. Rev. Lett.; 27: No. 22, 1548-50(29 Nov 1971).

The dips and breaks in proton–proton and proton–antiproton elastic scattering data are studied. All the structure is well understood in terms of the global curves of Odorico [Lett. Nuovo Cim., 2: 835 (1969)], which are simply curves of $\cos\varphi$ = constant, where $\cos\varphi$ is the proposed new variable. In particular, the low-energy $p\bar{p}$ data of Cline, English, and Reeder are reviewed and found to be well explained in terms of the Odorico curves. (auth)

7989 IMPORTANCE OF OFF-ENERGY-SHELL SCATTERING AND FERMI MOTION IN pid SCATTERING. Landau, Rubin H. (Univ. of Pittsburgh. Univ. of Illinois, Urbana). Nucl. Phys.; B35: No. 2, 390-6(1971).

Estimates are made of the changes in theoretical predictions of πd differential cross sections when Glauber multiple-scattering theory is extended to include the Fermi motion of the nucleons. The sensitivity of these calculations to the ambiguity in defining cm energy for off-energy-shell scattering is also investigated. (auth)

7990 PERIPHERAL DYNAMICS OF INCLUSIVE REACTIONS IN THE FRAGMENTATION REGION. Duimio, F.; Marchesini, G. (Univ., Parma, Italy. Istituto Nazionale di Fisica Nucleare, Milan). Phys. Lett.; 37B: No. 4, 427-31(13 Dec 1971).

Peripheral dynamics is studied for the limiting fragmentation of protons into protons and pions. The calculated distributions are discussed and compared with experimental data. (auth)

7991 MASS DEPENDENT SLOPES OF MOMENTUM TRANSFER DISTRIBUTIONS IN INCLUSIVE REACTIONS ACCORDING TO THE THERMODYNAMIC MODEL. Blutner, R.; Than, Htun; Matthaeus, E.; Ranft, G.; Ranft, J. (Karl-Marx-Univ., Leipzig). Nucl. Phys.; B35: No. 2, 503-10(1971).

Inclusive single particle spectra according to the thermodynamic model are studied in the form $d^2N/dtdM^*$. It is found, that the slopes of the momentum transfer dependence decrease with increasing $|t|$ in a similar way as found in experimental data. At small $|t|$ the slopes decrease with growing M* less strongly than found experimentally. The slopes differ also for different produced particles X. Furthermore the cross sections $d^2N/dtdM^*$ rise exponentially with growing M*, the slope depending again on the nature of the produced particle X. (auth)

7992 BACKWARD pd SCATTERING WITH A REALISTIC MODEL OF N AND N* EXCHANGES. Sharma, J. S. (Univ. of Delhi); Bhasin, V. S.; Mitra, A. N. Nucl. Phys.; B35: No. 2, 466-80(1971).

The differential cross section for pd scattering in the GeV range was calculated in terms of the contributions of N and N* exchanges. For the N-exchange contribution a relativistic deuteron form factor with appropriate S- and D-wave components is employed. For the N* exchanges, which are calculated in terms of a model of dNN* vertex developed separately by one of us (ANM), all the observed $I = {}^1\!/_2$ resonances up to 2 GeV (both positive and negative parities) are taken into account. The agreement with experiment at 1 GeV is extremely good over the entire angular range, a result in which contributions of the P_{11}, P'_{11} and D_{13} exchanges are found to be extremely important. At higher energies, while the agreement is good near the backward direction, the F_{15} exchange produces some distortion at intermediate angles. A possible mechanism for correcting this discrepancy is suggested. (auth)

7993 ABSORPTION OF NEGATIVE PIONS BY ^{3}He. Pajares, C. (Univ., Madrid); Pascual, R. Nucl. Phys.; B35: No. 2, 631-42(1971).

The absorption rate of negative pions in an s- and p-state by ^{3}He are compared, using Eckstein's phenomenological model. It is found that about 55% of the p-wave pions are absorbed directly by the nucleus. (auth)

7994 PROBLEMS IN np AND $\bar{p}p$ CHARGE EXCHANGE SCATTERING. Froyland, J. (CERN, Geneva); Winbow, G. A. Nucl. Phys.; B35: No. 2, 351-64(1971).

The Michigan model and a mixed model for $np \to pn$ and $\bar{p}p \to \bar{n}n$ scattering are compared, with particular emphasis on understanding the problem of over-absorption. Ways of checking absolute normalization of the two processes and their relative normalization are also presented. (auth)

7995 EFFECTS OF THE INTERMEDIATE N* STATE ON THE PROTON–^{4}He FORWARD ELASTIC SCATTERING AT 1 GeV. Ikeda, Miyo (Saitama Univ., Urawa, Japan). Progr. Theor. Phys. (Kyoto); 46: No. 4, 1088-95(Oct 1971).

The Glauber theory of multiple scattering is extended to take account of the contribution from N* as an intermediate state and is applied to the elastic scattering of a proton from ^{4}He at 1 GeV. The contribution arising from the inclusion of the N*(1236) state to the total cross section amounts to about 4% and has a remarkable effect around the second maximum in the differential cross section. (auth)

7996 SHRINKAGE OF FORWARD PEAKS OF ELASTIC PROTON–PROTON SCATTERING. Kawasaki, Mamoru; Yonezawa, Minoru (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 4, 1295-7(Oct 1971).

Recent ISR data from CERN show that the shrinking tendency of forward peaks of elastic pp scattering becomes weaker as the energy increases. It is shown the simple two-channel diffraction model is consistent with the observed behavior of forward slopes. (L.B.S.)

7997 ACCOMPANIMENT OF ENERGETIC NUCLEONS IN THE ATMOSPHERE. MacKeown, P. K. (Univ. of Maryland, College Park. Univ. Mayor de San Andres, La Paz, Bolivia). pp 684-94 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. III. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708–(Vol.3).

Distributions in the size of showers accompanying energetic (1- to 100-TeV) protons at mountain (530 g per sq cm) altitude are presented as a function of the released energy. The degree to which such accompanied protons may be confused with true residual protons is evaluated as a function of the efficiency in detecting such showers, for some specific cases. (auth)

7998 ISOBAR-FIREBALL MODEL AT VERY HIGH ENERGIES. Sitte, K. (CNR, Turin. Univ., Freiburg i. B.). pp 762-74 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. III. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708–(Vol.3).

A two-fireballs model is discussed in which the four-momentum transfer of the initial interaction is taken as the characteristic parameter, independently of the state of excitation of the emerging nucleons. Then purely kinematic considerations lead to a number of conclusions: Isobars cannot be produced in all collisions but only if the inelasticity exceeds a certain minimum value depending on the isobar mass μ_N. With increasing primary energy the average total inelasticity rises slowly from its initial value about 0.5 towards 0.6, while the fraction of energy transferred to the fireballs diminishes. The mass μ_N of the accessible isobar states increases only very slowly with the primary energy, and on the average is restricted to $\mu_N \lesssim 3.2$. Because of the decreasing "fireball inelasticity" the energy spectrum of the fireball secondaries produced by the primary cosmic radiation has a gradually steepening slope, with an asymptotic value of about −3.8. It is suggested that these features may explain a number of recent jet results without the assumption of new particles or states, and possibly also the characteristics of horizontal air showers. (auth)

7999 ANALYSIS OF HIGH-ENERGY JETS WITH THE TWO-TEMPERATURE MODEL OF HIGH-ENERGY INTERACTIONS. Crino, E.; Miguel, O.; Zgrablich, G. (Univ. Nacional de Cuyo, San Luis, Argentina). pp 789-803 of Proceedings of the VI Interamerican Seminar on Cosmic Rays. Vol. III. La Paz, Bolivia; Univ. Mayor de San Andres (1970).

From sixth interamerican seminar on cosmic rays; La Paz, Bolivia (19 Jul 1970). See CONF-700708–(Vol.3).

The behavior of several quantities related to high energy jets is developed and compared to experiments, using Wayland's (1967) two-temperature models of high energy interactions. A comparison is also made with predictions from Cocconi's (1958) two-fireball model. The two-temperature model of high energy interactions has already been tested with positive results for predictions of one-particle momentum spectra at accelerator energies. Extended to cosmic-ray energies, its predictions still prove largely satisfactory. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 8029.

8000 SPIN(4) GROUP AND THE MENDELEEV SYSTEM. Rumer, Yu. B.; Fet, A. I. (Inst. of Nuclear Physics, Novosibirsk, USSR). Teor. Mat. Fiz.; 9: No. 2, 203-10(Nov 1971). (In Russian).

It is shown that the group spin(4) described by Weyl and Brower governs the laws of the periodical system of chemical elements. (auth)

8001 HARMONIC ANALYSIS ON THE POINCARE GROUP. II. THE FOURIER TRANSFORM. Hai, Nghiem Xuan (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Commun. Math. Phys.; 22: No. 4, 301-20(1971).

The generalized matrix elements on the Poincaré group are used to write the Fourier transform explicitly. This realizes a mapping between positive type functions on the group and generalized density matrices. (auth)

8002 INVARIANT TENSORS IN SU(3). Dittner, P. (Queen Mary Coll., London). Commun. Math. Phys.; 22: No. 3, 238-52 (1971).

The construction of independent SU(3) tensors out of octets of fields is considered by investigating numerically invariant SU(3) tensors. A method of obtaining independent sets of these to any rank is discussed and also independent sets are explicitly displayed up to fifth rank. It is shown that this approach allows one to obtain relations among the invariant tensors, and useful new identities involving the d_{ijk} and f_{ijk} tensors are exhibited. (auth)

8003 T-, P-INVARIANT EQUATIONS IN 5-DIMENSIONAL MINKOWSKI SPACE. Sokur, L. P. (Inst. of Mathematics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 4, 574-8(Apr 1971). (In Russian).

Quantum-mechanical equations were obtained which are invariant with respect to the full group of de Sitter $\tilde{P}$ (1,4) and describe the multiplet of the arbitrary spin and isospin free particles. These equations represent the Bargmann–Wigner equation in the 5-dimensional space of Minkowski complemented with some matrix condition the form of which is completely determined by the values of the particle multiplet spin and isospin. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstract 8302.

8004 MICROSCOPIC IRREVERSIBILITY IN THE NEUTRAL KAON SYSTEM AND THE THERMODYNAMICAL ARROW OF TIME. I. CPT SYMMETRIC CASE. Aharony, Amnon (Tel-Aviv Univ., Israel). Ann. Phys. (N. Y.); 67: No. 1, 1-18(Sep 1971).

The master equation for the reduced density matrix of the neutral kaon system interacting with a (low temperature) boson gas is derived. The equation is transformed under time reversal (assuming CPT conservation) and the equations of motion in the direct and inverted time schemes are compared. The equations of motion are solved, in a perturbation method, and the explicit approach to thermodynamical equilibrium is described. The entropy production function for the kaonic decaying system is defined and calculated. It is shown that although the equilibrium state and the total entropy change during the approach to it are the same in both time schemes, the details of the entropy time dependence of a coherent initial state are different, thus suggesting a relation between microscopic and macroscopic arrows of time. (auth)

8005 REMARKS ON THE NEW UNITARITY BOUNDS OF $\langle K_L/K_S\rangle$. Gien, T. T. (Memorial Univ. of New Foundland, St. John's). Nuovo Cim.; 6A: No. 3, 319-27(1 Dec 1971).

The idea of grouping the CP violation theories into two classes by Fishbach and Nieto is generalized. It is found that the so-called stricter unitarity bound to $|\alpha| = |\langle K_L/K_S\rangle|$ discussed by these authors can actually be chosen arbitrarily in a wide range of values subjected only to certain restrictions. It is also pointed out that there always exists a lower bound to $|\alpha|$ which is either equal to zero or, in some cases, to a positive value known in terms of the partial decay rates of K_L and K_S. A discussion with reference to experimental data and the Wu-Yang triangle is again given for comparison. (auth)

Applications (Strong)

8006 NARROW PEAKS NEAR η'(958). Tuan, S. F. (Univ. of Hawaii, Honolulu). Phys. Rev., D; 4: No. 5, 1574-6(1 Sep 1971).

It is pointed out that recent evidence for sharp mesonic peaks near the η'(958) may lend support to a theory proposed some years back that the broken nonchiral SU(2) ⊗ SU(2) symmetry is relevant to classification of hadronic states. (auth)

8007 CORRECTIONS TO SOFT-MESON THEOREMS AND BREAKING OF CHIRAL $SU_3 \otimes SU_3$ (A WEAK PCAC, NARROW-RESONANCE APPROACH). Gensini, P. (Univ., Lecce, Italy). Nuovo Cim.; 6A: No. 2, 259-76(21 Nov 1971).

The problem of corrections to soft-meson theorems is considered from a "weak" PCAC point of view and indications are obtained, comparing the results with experiment, on the structure of chiral $SU_3 \otimes SU_3$ symmetry breaking. $(3, \bar{3}) \oplus (\bar{3}, 3)$ behavior of the symmetry-breaking Hamiltonian is favored over $(1, 8) \oplus (8, 1)$, but no indication can be found on the relative strength of the two components of a $(3, \bar{3}) \oplus (\bar{3}, 3)$ symmetry breaking to choose between the pattern forwarded by Gell-Mann, Oakes and Renner, who suggest $SU_2 \otimes SU_2$ as the "less broken" symmetry, and the one proposed by Brandt and Preparata, who prefer instead SU_3 as a better symmetry than $SU_2 \otimes SU_2$. (auth)

8008 POSSIBILITY OF P, T VIOLATING BUT C = PT CONSERVING STRONG INTERACTIONS. Yamaguchi, Yoshio (Tokyo Univ.). J. Phys. Soc. Jap.; 31: No. 6, 1605-7(Dec 1971).

A possibility of P- and T-violating but C = PT conserving strong interactions is discussed. It is pointed out that there exist strong interaction models in which P and T are reasonably well satisfied at low momentum transfer regions while they are violated in large momentum transfer phenomena. (Another possibility is given by C- and T-violating but P = CT invariant strong interactions.) The two pion decay of the long-lived neutral kaon can naturally be interpreted as the clash between C (or P) conserving strong interactions and T invariant weak couplings. This type of strong interaction model can naturally be formulated on the basis of Schwinger's dyon theory. It is suggested that the mass of dyons (dually charged particles) is roughly fifteen times nucleon mass. (auth)

8009 LOCAL ONE PARTICLE APPROXIMATION OF THE CURRENT COMMUTATORS. Fakirov, Dotcho G.; Marinescu, Nicolae (Univ., Heidelberg). Z. Phys.; 247: No. 5, 421-35 (1971).

The spectral functions of the current commutator matrix elements between vacuum and one-particle boson states are calculated in a local one-particle approximation. In the equal-time limit, the restrictions imposed by the current algebra commutation relations without operator Schwinger terms are systematically discussed. In this approximation, it is found that when one of the currents is conserved, the PCAC and vector meson dominance models cannot be considered simultaneously. The comparison of the results with experiment gives preference to the first of the two models. (auth)

Field Theories

General

Refer also to abstract 8045.

8010 A NEW THEORY OF ELEMENTARY MATTER. PART II. ELECTROMAGNETIC AND INERTIAL MANIFESTATIONS. Sachs, Mendel (State Univ. of New York, Buffalo). Int. J. Theor. Phys.; 4: No. 6, 453-76(Oct 1971).

In accordance with the philosophical approach and its mathematical implications that were derived in Part I of this series [Int. J. Theor. Phys; 4: No. 6, 433(Oct 1971)] the manifestations of matter that are concerned with its electromagnetic and inertial properties are dealt with explicitly. It is demonstrated that a logically and mathematically generalized version of electromagnetism emerges from extending the Faraday–Maxwell field approach, so as to fully unify these features of matter with the field description of matter itself. It is then shown how the most general expression of matter (according to the axioms of this theory), in terms of two-component spinor fields in a Riemannian space, leads to a derivation of the inertial properties of matter. The mass field so-derived: is a positive-definite function of the (global) coordinates—implying that gravitational forces can only be attractive; approaches a discrete spectrum of values as the mutual coupling among the matter components of the closed system becomes arbitrarily weak; predicts mass doublets in this approximation; and approaches zero as the closed system becomes depleted of all other matter (in accordance with the Mach principle). It is also proven, as a consequence of the same field theory, that electromagnetic forces can be attractive or repulsive, depending on certain features of the geometrical fields of the Riemannian space. (auth)

8011 NONCONSERVATION OF THE NEWMAN–PENROSE CONSERVED QUANTITIES. Press, William H.; Bardeen, James M. (California Inst. of Tech., Pasadena). Phys. Rev. Lett.; 27: No. 19, 1303-6(8 Nov 1971).

The Newman–Penrose quantities were examined for test fields in a Schwarzschild background. It is found that, unless a static condition has prevailed in the infinite past, backscattered electromagnetic and gravitational waves make it impossible to define the quantities as limits at future null infinity. An operational definition in terms of observations at finite radii is possible, but yields quantities which are not conserved. (auth)

8012 PLANE NON-ABELIAN YANG–MILLS WAVES. Treat, R. P. (West Virginia Univ., Morgantown). Nuovo Cim.; 6A: No. 2, 121-8(21 Nov 1971).

Plane non-Abelian propagating solutions of the classical Yang–Mills equations without external sources are obtained. The non-electromagneticlike properties of the waves, which arise from the non-linearities of the field equations, cause the energy-momentum vector density of the waves to be timelike. (auth)

8013 CONSERVED QUANTITIES AND RADIATION EFFECTS FOR A CLOSED SYSTEM OF CHARGED PARTICLES. Stettner, Roger (Univ. of Chicago). Ann. Phys. (N. Y.); 67: No. 1, 238-51(Sep 1971).

Quantities conserved to $O(c^{-2})$, for a closed system of charged particles in motion, are derived from the electromagnetic energy-momentum tensor by making use of a fluid description. These quantities are compared with those derived from the Darwin Lagrangian. The approximation is taken one step beyond to $O(c^{-3})$ to show explicitly how quantities that are conserved to $O(c^{-2})$ change with time when electric-dipole radiation is later taken into account. (auth)

Quantum Field Theory

Refer also to abstracts 7695, 7696, 7766, 7782, 7835, and 7938.

8014 STRUCTURE OF ANALYTIC RENORMALIZATION. Speer, Eugene R. (Massachusetts Inst. of Tech., Cambridge). Commun. Math. Phys.; 23: No. 1, 23-36(1971).

A direct proof is given that analytic renormalization has an additive structure and hence may be implemented by counterterms in the Lagrangian. (auth)

8015 SMALL-DISTANCE-BEHAVIOR ANALYSIS AND WILSON EXPANSIONS. Symanzik, K. (DESY, Hamburg). Commun. Math. Phys.; 23: No. 1, 49-86(1971).

A previously described method to obtain the asymptotic forms of vertex functions at large momenta is, with the help of Wilson operator product expansion formulas, extended to momenta where the vertex functions of the zero-mass theory underlying the asymptotic forms are infrared singular. To obtain from asymptotic forms information on asymptotic behavior requires assumptions on the bahavior of the zero-mass theory in the limit of infinite dilatation. One particular set of assumptions is discussed and found to pass a simple consistency test; this set of assumptions leads to power laws, or slight modifications thereof, with coupling-constant-independent exponents. The detailed discussion is given for the ϕ^4 model. (auth)

8016 PREDICTIVE RELATIVISTIC MECHANICS. Bel, Luis (Univ., Paris). Ann. Inst. Henri Poincard, Sect. A: 14: No. 3, 189-203(1971).

Several papers on predictive relativistic mechanics are reviewed. The meaning of the so-called "no interaction theorems' is examined, and solutions to some open problems are proposed. (auth)

8017 INTEGRAL REPRESENTATION OF THE WIGHTMAN FUNCTIONS IN TWO-DIMENSIONAL SPACE–TIME. Zharinov, V. V. (Moscow Physical-Technical Inst.). Teor. Mat. Fiz.; 9: No. 2, 232-9(Nov 1971). (In Russian).

The description of the extended tube is given and the integral representation for the Wightman functions of arbitrary order in two-dimensional space–time is constructed, which takes into account in an explicit form the Lorentz covariance and the spectrum condition. (auth)

8018 CONSTRUCTIVE FIELD THEORY: INTERACTION $(\bar{\psi}\gamma^{\mu}\psi)^2_2$: THE THIRRING MODEL. I. LOCAL FIELD. Volovich, I. V.; Sushko, V. N. (Mathematics Inst., Moscow. All-Union Scientific-Research Inst. of Current Sources, Moscow). Teor. Mat. Fiz.; 9: No. 2, 211-31(Nov 1971). (In Russian).

A self-interacting fermion field with a zero rest mass in two-dimensional space–time is investigated by methods of the so-called constructive field theory. The renormalized Hamiltonian including cut-off form factors and counter-terms of a definite structure and the Heisenberg field corresponding to this Hamiltonian are constructed. The space of physical particles is explicitly described, in which both the Hamiltonian and the Heisenberg field admit the removal of the ultraviolet cut-off. The Wightman functions corresponding to the local field obtained admit the removal of the spatial cut-off. The form of the counter terms is found, with which the limit Wightman functions coincide with those constructed by Klaiber. (auth)

8019 RELATIVISTIC QUANTUM MECHANICS AND THE S-MATRIX. Polkinghorne, J. C. (Cambridge Univ., Eng.). Sci. Progr. (Oxford); 59: No. 236, 551-72(Winter 1971).

Quantum field theories were the first realizations of the combination of quantum theory with special relativity. However, they purport to calculate more than can be measured for they are not restricted to the "mass shell". S-matrix theory is an attempt to pare away unobservable entities and to work with quantities directly related to the results of scattering experiments. Its basic properties are: quantum mechanics; Lorentz-invariance; connectedness structure; unitarity; analyticity; crossing symmetry. Modern theories of strong interactions also make much use of further special dynamical ideas. Principally these are: bootstraps; Regge theory; duality. (auth)

8020 GENERAL STATIONARY GRAVITATIONAL VACUUM FIELD OF CYLINDRICAL SYMMETRY. Frehland, Eckart (Univ., Freiburg i. B.). Commun. Math. Phys.; 23: No. 2, 127-31(1971).

The general stationary vacuum gravitational field of cylindrical symmetry as recently found by Davies and Caplan is even static. The possible Petrov types of the Riemann tensor are I, D or O. In spacelike infinity the spacetime becomes necessarily flat. (auth)

8021 ALMOST POSITIVE PERTURBATIONS OF POSITIVE SELFADJOINT OPERATORS. Konrady, John (Univ. of Maryland, College Park). Commun. Math. Phys.; 22: No. 4, 295-300(1971).

Let A be a positive selfadjoint operator and let B be a symmetric perturbation of A. Sufficient conditions for the essential selfadjointness of A + B on domains where A is essentially selfadjoint are established. The results have application to the $\lambda\phi^4$ field theory in two space–time dimensions. (auth)

8022 POSITIVITY AND SELF ADJOINTNESS OF THE $P(\phi)_2$ HAMILTONIAN. Glimm, James (New York Univ., N. Y.); Jaffe, Arthur. Commun. Math. Phys.; 22: No. 4, 253-8(1971).

A new proof that the locally correct Hamiltonian H(g) is self adjoint, and that the vacuum energy E(g) = inf spectrum H(g) satisfies $-O(D) \leqq E(g)$, where $0 \leqq g \leqq 1$ and D = diam. supp. g is given. (auth)

8023 RENORMALIZABLE LAGRANGIANS FOR MASSIVE YANG-MILLS FIELDS. Hooft, G.'t (Univ. of Utrecht). Nucl. Phys.; B35: No. 1, 167-88(1971).

Renormalizable models are constructed in which local gauge invariance is broken spontaneously. Feynman rules and Ward identities can be found by means of a path integral method, and they can be checked by algebra. In one of these models, which is studied in more detail, local SU(2) is broken in such a way that local U(1) remains as a symmetry. A renormalizable and unitary theory results, with photons, charged massive vector particles, and additional neutral scalar particles. It has three independent parameters. Another model has local SU(2) ⊗ U(1) as a symmetry and may serve as a renormalizable theory for ρ-mesons and photons. In such models electromagnetic mass-differences are finite and can be calculated in perturbation theory. (auth)

8024 REGGE TRAJECTORIES IN THE WICK–CUTKOSKY MODEL. Murai, Nobuyuki (Tokyo Univ.); Nakamura, Koichi, Ezawa, Hiroshi. Progr. Theor. Phys. (Kyoto); 46: No. 3, 909-37(Sep 1971).

Regge trajectories $n(\eta^2)$ in the Wick-Cutkosky model ($\eta^2 = 1/4$ of the center-of-mass energy squared) are obtained by numerical computations as supplemented by some analytical observations. Careful numerical analysis revealed that the trajectories undergo repulsive collisions besides the attractive ones that had been discovered by Gatto and Menotti. Formulas are obtained by analytical methods that exhibit the attractive collisions as well as crossings of trajectories explicitly. The asymptotic behavior of trajectories as $\eta^2 \to -\infty$ is established rigorously in a way more direct than Gatto and Menotti's and are shown by numerical checks to provide good approximations when $-\eta^2 > 100$. Based on these results, a description is given of the global pattern of the trajectories. (auth)

8025 SOLUTIONS OF THE BETHE–SALPETER EQUATION: THE CASE OF $P_\pi = 0$, GENERAL L. Aotsuka, Tsuyoshi; Munakata, Yasuo (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 3, 897-908(Sep 1971).

The solutions of the scalar ladder model of the Bethe-Salpeter equation are obtained for the case of $P_\mu = 0$ but of general L (magnitude of Lorentz angular momentum). The solutions are obtained in a form of a single dispersion integral of superconvergent type, the absorptive part of which can be expressed as a rapidly convergent power series in λ, the coupling constant. The eigenvalues λ_L's are determined as the zeros of an entire function for each L. The asymptotic form of the solutions is clarified. Numerical results are obtained for L = 0 and for the ground and the first excited states and compared with that of zur Linden. (auth)

8026 PROBLEM OF GAUGE INVARIANCE IN LOCAL FIELD THEORY. Taguchi, Yukio (Osaka Univ.); Yamamoto, Kunio. Progr. Theor. Phys. (Kyoto); 46: No. 3, 1003-5(Sep 1971).

It is shown that the difficulty of the photon self-energy is completely solved by taking into account normal dependent terms, and that in the two-dimensional quantum electrodynamics the normal dependent terms required by the covariant and integrability conditions of the Tomonaga–Schwinger equation are identical. (L.B.S.)

8027 INTEGRABILITY CONDITION IN LOCAL FIELD THEORY. Yamamoto, Kunio (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 3, 1002-3(Sep 1971).

It is pointed out that normal dependent terms are needed in the integrability condition in quantum field theory to obtain covariant results. It is also pointed out that gauge invariance also requires normal dependent terms. (L.B.S.)

8028 PROBLEM OF LORENTZ INVARIANCE IN LOCAL FIELD THEORY. Taguchi, Yukio (Univ. of Osaka); Yamamoto, Kunio. Progr. Theor. Phys. (Kyoto); 46: No. 3, 1000-1(Sep 1971).

The problem of Lorentz invariance in local field theory is related to that of noncovariant terms in divergent integrals. A covariant finite field theory is developed. (L.B.S.)

8029 ASYMPTOTIC SCALE INVARIANCE AND THE POINT-SOURCE LEE MODEL. Bui-Duy, Q. (Univ. of Montreal). Nuovo Cim.; 6A: No. 2, 163-74(21 Nov 1971).

The renormalized two-point function in the point-source Lee model with indefinite metric is shown to be continuous at short distances. A Ward identity for scale invariance in fixed point-source field models is derived. The dimension of the renormalized field is canonical. The appearance of logarithmic functions in the short-distance behavior of the model is attributed to the lack of scaling among high-energy eigenstates. (auth)

8030 NONPERTURBATIVE SOLUTION OF THE RENORMALIZED LEE MODEL. Esposito, F.; Esposito, U. (CNR, Naples). Nuovo Cim.; 6A: No. 2, 277-87(21 Nov 1971).

In this work a model of field theory with a Lagrangian (Lee's model) is studied. By means of a very simple method employing canonical commutation rules, the equation for the V-particle propagator in the first sector is obtained without making use of the perturbative expansion. The equation thus obtained is regularized not by cut-offs, but by an analytic regularization method. The solution shows an additional pole as a result of nonlinear equations for the mass of the V-particle. (auth)

8031 S-MATRIX THEORY OF THE LAMB SHIFT. II. Artru, X.; Fontannaz, M. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Ann. Phys. (N. Y.); 67: No. 1, 199-237(Sep 1971).

The S-matrix theory and the Dashen–Frautschi technique are applied to the Lamb shift. The formalism was previously developed in which the problem of the infrared divergence was solved and the term in $\alpha(Z\alpha)^4$ Log $Z\alpha$ of the Lamb shift was obtained. No ultraviolet divergences appear in the calculations. The contributions in $\alpha(Z\alpha)^4$ of the "nonrelativistic cuts," which correspond to the "Bethe logarithm" and to the anomalous magnetic moment term, are estimated. The approximate value of the Bethe logarithm is 3.25 for the 2S state, and $\Delta E_{2S} = 980$ Mc is obtained. For the anomalous magnetic moment term, analyticity assumptions lead to an exact result. The approximate value of $\Delta E_{2P_{1/2}}$ is +7Mc. The radiative corrections to the low energy Compton amplitude (for spin 0 particles) are also obtained using dispersion relations. (auth)

8032 LORENTZ TRANSFORMATIONS IN THE PRESENCE OF A UNIFORM GRAVITATIONAL FIELD. Broucke, R. (Univ. of California, Los Angeles. California Inst. of Tech., Pasadena). Amer. J. Phys.; 39: No. 12, 1465-7(Dec 1971).

A Lorentz-like transformation between a fixed frame and an inertial frame that is free falling due to the presence of a uniform gravitation field is described. The application to the clock paradox problem and some connections with similar works are also discussed. (auth)

8033 S-MATRIX THEORY OF THE LAMB SHIFT. I. Artru, X. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Ann. Phys. (N. Y.); 67: No. 1, 158-98(Sep 1971).

The S-matrix theory and the Dashen–Frautschi technique are applied to the Lamb Shift. No ultraviolet divergence is encountered and no subtraction constant is introduced. The infrared divergence is eliminated by a general method. Only the lowest order in α and $Z\alpha$ is taken into account, and (a) the exact coefficient of $\alpha(Z\alpha)^4$ Log $Z\alpha$, are (b) an approximate value for the coefficient of $\alpha(Z\alpha)^4$ ("The Bethe Logarithm") are obtained. The $\alpha(Z\alpha)^4$ Log $Z\alpha$ term, the vacuum polarization, and the infrared divergence problem are studied. Paper II is devoted to the Bethe Logarithm and the anomalous magnetic moment. (auth)

8034 WHY DILATATION GENERATORS DO NOT GENERATE DILATATIONS. Coleman, Sidney (Harvard Univ., Cambridge, Mass.); Jackiw, Roman. Contracts AT(30-1)-2098; F44620-70-C-0030. Ann. Phys. (N.Y.); 67: No. 2, 552-98(Oct 1971).

It is shown that the Ward identities associated with broken scale invariance contain anomalies in renormalized perturbation theory. In low orders, these anomalies can be absorbed into a redefinition of the scale dimensions of the fields in the theory, but in higher orders this is not possible. Also, these anomalies cannot be removed by studying the Green's functions for objects other than canonical fields, e.g., currents. These results are established to first nontrivial order in perturbation theory by explicit Feynman calculations (which give information at all momentum transfers), and in higher orders by the method of Callan and Symanzik (which gives information only at zero momentum transfer). The two approaches are consistent within their common domain of validity. Self-contained treatments of the formal canonical theory of scale and conformal transformations and of the derivation of Ward identities are given. The Callan–Symanzik equations for Green's functions of currents are derived and it is shown that no redefinition of scale dimension is necessary for these objects, although the other anomalies remain. (auth)

8035 QUANTUM FIELD THEORY AND HYDRODYNAMICS. Skobel'tsyn, D. V. (ed.). Proc. (Tr.) P. N. Lebedev Phys. Inst. (USSR) (Engl. Transl.); 29: 1-271(1967).

Translated from Tr. Fiz. Inst., Akad. Nauk SSSR; 29: 1-271 (1967).

Separate abstracts for these papers were prepared from the original language and appeared in NSA under the abstract numbers: 21:888, 889, 890, 4119, and 7556.

8036 HISTORY INTEGRAL FOR THE FREE SCALAR QUANTIZED FIELD. Tarski, Jan (Univ., Paris. Univ., Amiens, France). Ann. Inst. Henri Poincare, Sect. A; 15: No. 2, 107-40 (1971). (In French).

The history integral for the free scalar field is constructed, by adapting Ito's definition of the path integral. The main properties of this integral are discussed: integrability of certain characteristic functionals, representation of time-ordered vacuum expectation values, and composition laws. (France)

8037 EXTENSION OF WHEELER–FEYNMAN QUANTUM THEORY TO THE RELATIVISTIC DOMAIN. I. SCATTERING PROCESSES. Davies, P. C. W. (Cambridge Univ., Eng.). J. Phys., A (London); 4: No. 6, 836-45(Nov 1971).

The quantization of Wheeler–Feynman direct interparticle action electrodynamics is refined and extended to the relativistic domain, using the S matrix technique developed previously. The analysis is effected on the exact expression for S, rather than the perturbation expansion. Source particles are treated as indistinguishable fermions with antiparticles. The response of the universe is incorporated in a general way, without allusion to specific absorber mechanisms. All the results of conventional QED emerge, provided one makes certain cosmological assumptions. (auth)

8038 WYLER'S EXPRESSION FOR THE FINE-STRUCTURE CONSTANT α. Robertson, Baldwin (National Bureau of Standards, Washington, D. C. Stanford Linear Accelerator Center, Calif.). Phys. Rev. Lett.; 27: No. 22, 1545-7(29 Nov 1971).

Wyler's expression for α in terms of the Euclidean volumes of certain bounded spaces agrees with experiment only if the radius of these spaces is arbitrarily chosen to equal 1. However, the relation between these spaces and the invariance group O(n,2) of the n-dimensional wave equation is independent of the radius. There is no known reason for setting the radius equal to one. (auth)

8039 GENERALIZED LORENTZ GAUGE DESCRIPTION OF QUANTUM ELECTRODYNAMICS. Tomczak, Steven Paul. Storrs, Conn.; Univ. of Connecticut (1971). 96p. University Microfilms Order No. 71-29,918.

Thesis.

A unified formulation of quantum electrodynamics in the generalized Lorentz gauge (including, for example, the Feynman, Landau, and Yennie–Fried gauges) is presented. The formulation is shown to be consistent with the appropriate commutation relations and propagators in the various gauges. All the gauge descriptions are shown to lead to Maxwell's equations in the Lorentz gauge provided that expectation values of the electric and magnetic field intensities are taken over physically admissible states. It is shown that when the subsidiary condition is properly treated for the case of interacting photons and charged particles, the various gauge descriptions have the same physical content and identical wave function renormalization constants, as in the Coulomb gauge. (Diss. Abstr. Int., B)

8040 INCONSISTENCY OF THE QUANTIZATION SCHEME OF KADEMOVA AND KRAEV. Bracken, A. J.; Gray, D. A. (Univ. of Adelaide). Phys. Lett.; 37B: No. 4, 420-1(13 Dec 1971).

The quantization scheme recently proposed by Kademova and Kraev is shown to be inconsistent. There is no apparent way in which it can be modified in order to provide a scheme liable to a reasonable physical interpretation. (auth)

8041 CONFORMAL INVARIANCE AND BOOTSTRAP. Migdal, A. A. (Inst. for Theoretical Physics, Moscow). Phys. Lett.; 37B: No. 4, 386-8(13 Dec 1971).

Bootstrap equations for three point Wightman functions at small distances are formulated. The equations are proved to have a conformally invariant solution. Ultraviolet and infrared divergences are absent. (auth)

8042 0(3,1) HARMONICS AND ITS APPLICATION TO BETHE–SALPETER EQUATION. Seto, Kenji (Gakushuin Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 46: No. 4, 1248-60(Oct 1971).

The O(3,1) harmonics are introduced as an extension of the O(2,1) ones given by Sertorio–Toller and are applied to solve the Bethe–Salpeter equation in the Wick–Cutkosky model without using the Wick-rotation. It is shown that the equation has physically unacceptable eigenvalues corresponding with complex-valued coupling constants which are connected to the eigenvalues known already through the O(4) symmetry by an analytical continuation in the four-dimensional angular momentum quantum number. On the other hand, it is shown that the solutions through the O(4) symmetry themselves cannot become solutions in our approach in a strict sense. The lightlike limit of the harmonics is also discussed, where the E(2) harmonics are derived as a limit of the O(3,1) ones. (auth)

8043 QUANTIZATION IN NON-LINEAR THEORIES. Kimura, Toshiei (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 4, 1261-77(Oct 1971).

The canonical quantization of nonlinear Lagrangians is discussed. When one can find a Cartesian coordinate system Q^{α} (reducible case), the covariant Hamiltonian can be obtained by starting with the Lagrangian $L = (1/8)g^{-1/4}\{g_{im}, \dot{q}^{m}\}g^{1/2}g^{ij}\{g_{jn}, \dot{q}^{n}\}g^{-1/4} - v(q)$. On the other hand, when no overall flat coordinate system can be found, a local Euclidean frame is attached at each point in q-coordinate space and auxiliary variables are introduced in order to obtain the Hamiltonian. It is shown that the procedure is not covariant under a local rotation of n-legs. In a reducible case, the quantum mechanical transformation operator from Q^{α} to q^{i} is found and the unitarity of the operator is verified in quantum mechanics. Extension to non-linear field theories is carried out, and the transformation operator is shown to be an abnormal operator in particle number representations though it is formally unitary. (auth)

8044 QUANTUM FIELD THEORY OF COMPLEX MASS. II. Yamamoto, Hiroshi; Kudo, Kiyoshi (Fukui Univ., Japan). Progr. Theor. Phys. (Kyoto); 46: No. 4, 1278-89(Oct 1971).

An attempt is made to further clarify some unsatisfactory points in a previous paper. First a new conjugation is introduced. The conjugation exists in the case of complex mass and is similar to the hermitian conjugation. Connections between these two conjugations are clarified. The transformation properties of some operators under these conjugations are studied. It is seen that the Hamiltonian is not hermitian in the whole Hilbert space. Our S-matrix is proved to be probabilistically interpretable. Lastly the present theory is compared with that of Lee and Wick. (auth)

Gravitation and General Relativity

8045 PHOTONS, NEUTRINOS, ELECTRONS, AND BARYONS IN A UNIFIED SPINOR FIELD THEORY OF RELATIVITY. Littlewood, D. E. (University Coll. of North Wales, Bangor). Int. J. Theor. Phys.; 4: No. 6, 403-25(Oct 1971).

A mathematically precise model may be constructed by considering a distribution of basic spinors in a Kaluza 5-space, such that: The basic spinors W satisfy $\mathrm{curl}_5\, W = 0$; the four-dimensional curvature is in accordance with Einstein's general theory, taking the energy-momentum-tension tensor as $T_{ij} = k_1Q_iQ_j + k_2P_iP_j + k_3g_{ij}(P^kP_k)$ where $Q_i = \widetilde{W}TX_iW, P_2 = \widetilde{W}T\phi X_iW$, and the ratios $k_1 : k_2 : k_3$ are adjustable to give the best fit, and the five-dimensional curvature associated with the electromagnetic field is determined by the concomitant $F_{ij} = \widetilde{W}TX_iX_jW$. In this model there can exist wave packets which behave in exactly the same way as the physical properties of photons, neutrinos, electrons and baryons. This model is certainly a very close fit to the physical world as we know it. (UK)

8046 RELATIVISTIC PROBLEM OF MOTION IN CO-MOVING CO-ORDINATES. Massa, Enrico (Univ., Genova, Italy). Commun. Math. Phys.; 22: No. 4, 321-37(1971).

The role of co-moving atlases is discussed in connection with a possible formulation of the problem of motion in general relativity. The concept of co-moving scheme is defined and applied to various cases of physical interest. In particular in the Einstein–Maxwell case, a general uniqueness proof for the Maxwell equations is derived. The dynamical meaning of the equation $T^{ij}{}_{||j} = 0$ is proved, and a scheme for the solution of the problem of motion in co-moving co-ordinates is proposed. (auth)

8047 PATHS OF CHARGES IN GENERAL RELATIVITY AS GEODESICS OF EINSTEIN'S NON-RIEMANNIAN GEOMETRY. Burman, R. R. Bull. Aust. Math. Soc.; 4: No. 2, 69-84(1971).

The equation of motion of charged incoherent matter, and hence of a test charge, in general relativity can be written as the geodesic equation of an affine connection. The connection is chosen to satisfy a condition which has the form of one of the basic geometrical principles of Einstein's unified field theory. The symmetric part of the fundamental tensor of the geometry is chosen to be the metric tensor of general relativity; equations to be satisfied by the skew part, involving the electromagnetic field, are obtained. An alternative condition on the affinity is also considered. (auth)

8048 ROLE OF THE UNCERTAINTY PRINCIPLE IN GENERAL RELATIVITY AND THE LIMITING SIZE OF COLLAPSING FERMION SPHERES. Hokkyo, Noboru (Hitachi Atomic Energy Research Lab., Kawasaki). Progr. Theor. Phys. (Kyoto); 46: No. 3, 984-9(Sep 1971).

An attempt is made to modify the Schwarzschild metric by the uncertainty principle in space regions of the linear size of the order of the Planck length $L^* = (\hbar G/c^3)^{1/2} \sim 10^{-33}$ cm, and the role of the modified metric in avoiding the unlimited gravitational collapse of superdense Fermion spheres is examined. It is seen that the effect of the uncertainty principle is to introduce, at the center of symmetry of the system, a "repulsive hole" in which the matter is energetically unstable against the escape to outer regions. The radius of this hole for a system of mass M and radius R is seen to be $L^*(R/R_{gr})^{1/2}$, where $R_{gr} = 2GM/c^2$ is the gravitational radius associated with the mass M. The limiting radius and mass of the collapsing extreme relativistic Fermi gas are roughly given by $N^{1/2}L^*$ and $N^{1/2}m^*$, respectively, where N is the number of particles in the gas and $m^* = \hbar/cL^* = (\hbar c/G)^{1/2} \sim 10^{-5}$ g is the Planck mass. (auth)

8049 LINEARIZATION OF SCHWARZSCHILD'S LINE ELEMENT: APPLICATION TO THE CLOCK PARADOX. Broucke, R. (Univ. of California, Los Angeles. California Inst. of Tech., Pasadena). Amer. J. Phys.; 39: No. 12, 1461-5 (Dec 1971).

The relativistic theory of the motion of a particle in the presence of a uniform acceleration field is studied. The problem is introduced as a linearization of the fundamental line element of general relativity. The linearized line element is a solution of Einstein's field equations. The equations of geodesics corresponding to this line element are solved and applied to the clock paradox problem. (auth)

8050 INERTIAL AND GRAVITATIONAL MASS IN THE BRANS–DICKE THEORY. **Ohanian, Hans C. (Rensselaer Polytechnic Inst., Troy, N. Y.). Ann. Phys. (N.Y.); 67: No. 2, 648-61(Oct 1971).**

The equality of inertial and gravitational mass in the Brans–Dicke theory of gravitation is investigated in both the classical and quantum case. A general expression for the ratio of inertial to gravitational mass for any classical static or quasistatic system is derived. Although the ratio differs from one, in violation of the principle of equivalence, the difference is small (of the order of magnitude of (gravitational potential energy)/(rest mass)). In the quantum case, it is found that the gravitational self-energy of a particle contributes to the gravitational mass in such a way that the principle of equivalence is not necessarily satisfied. Thus, in contrast to Einstein's theory, the Brans–Dicke theory does not contain the principle of equivalence for quantum particles. (auth)

8051 DILATON AND POSSIBLE NON-NEWTONIAN GRAVITY. **Fujii, Yasunori (Tokyo Univ.). Nature (London) Phys. Sci.: 234: No. 44, 5-7(1 Nov 1971).**

A model is proposed which allows a dilaton (boson of dilatation invariance) to show up in a possible non-Newtonian part of the gravitational force. By examining the available observational facts it can be shown that the force-range of the additional force, if it exists, will be either between 10 m and 1 km or smaller than ~1 cm. (auth)

8052 WHAT FLUX LIMITS CAN BE SET FOR X-RAY PULSES ACCOMPANYING WEBER'S PULSES? **Jelley, J. V. (Atomic Energy Research Establishment, Harwell, Eng.). Nature (London); 234: No. 5325, 142-3(19 Nov 1971).**

It is stated that the vast ratio, $\sim 10^{-40}$, between gravitational and electromagnetic forces has prompted a search for radio pulses that might accompany the pulses reported by Weber (Phys. Rev. Lett. 22: 1320 (1969) and 25: 180 (1970)). Bandwidths in the radio experiments are, however, restricted, and there are uncertainties about the dispersion in the interstellar plasma, and for these reasons sensitivities that might be attained in other regions of the electromagnetic spectrum are discussed. In this connection attention is drawn to the potential of the upper-air x-ray fluorescence technique, which is ground-based, cheap in application, has a wide input energy bandwidth, and is nondirectional. The question of how small a fraction of the energy in the pulses of gravitational radiation (GR) would have to be emitted in the x-ray band to be detectable by this method is discussed, assuming that GR events arise from collapsing objects at the galactic center. The vital question of the time-scale is discussed in this connection. Other matters discussed include the effect of photoelectric absorption in the interstellar medium and scattering of dust. It is stated that when lists of the times of occurrence of GT events are published by Weber, or others, a single night-sky fluorescent receiver may be sufficient to set a low limit on the x-ray flux accompanying these events. (UK)

8053 CHARACTERISTIC ROTATION OF BODIES IN THE GENERAL THEORY OF RELATIVITY. **Ryabushko, A. P. (Belorussian Inst. of Agricultural Mechanics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 4, 91-6(1971). (In Russian).**

Equations of characteristic rotation and their integrals were investigated for systems of rotating bodies. The characteristic angular moment of momentum of each body was strictly constant (and not only with the accuracy of secondary members) for an accompanying observer. The precession time of the axes of characteristic rotation of the body was evaluated. For example, in the case of neutron stars, the axis of rotation of its closely rotating satellite completes a full revolution in a few hours. In the case of bodies of comparable mass problems of the stability of motion are raised. Equations of motion in the post-Newtonian approximation are regarded as perturbed Newtonian equations of motion in curved space. The characteristic Newtonian rotation of bodies is unstable according to Lyapunov from the point of view of general relativity. (tr-auth)

8054 DUALITY AND ALGEBRAIC CLASSIFICATION OF EINSTEIN SPACE. **Petrovich, G. I. (Belorussian State Univ., Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 4, 97-102(1971). (In Russian).**

The proof of the symmetric duality theorem of tensor matrices of the curvature of Einstein space in real bivector space is not a choice of specialized coordinates, but the existence of duality as an essential condition for the construction of this space. The role of duality for the construction of a complex bivector basis is examined, relative to which the tensor matrix of Einstein's space curvature disintegrates into two mutually complex symmetrical three-dimensional units. (tr-auth)

8055 SPINOR FIELDS IN GENERAL RELATIVITY. I. NOETHER'S THEOREM AND THE CONSERVATION LAWS IN RIEMANN–CARTAN SPACE. **Datta, B. K. (Univ., Stuttgart). Nuovo Cim.; 6B: No. 1, 1-15(11 Nov 1971).**

The concept of spinors which transform according to the unimodular group is analyzed on the basis of Riemann-Cartan geometry. Using the principle of minimal coupling, one obtains a matter Lagrangian, which differs from the Lagrangian of the conventional theory of general relativity in that it is also a function of torsion. Conservation laws are derived by considering the invariance of the action function under infinitesimal coordinate and spin transformations. These conservation laws or identities lead to the definition of an asymmetric energy-momentum tensor, the antisymmetric part of which is related to the spin angular momentum. It is also shown that the force acting on the material system depends on the spin of the material and on the curvature. (auth)

8056 SPINOR FIELDS IN GENERAL RELATIVITY. II. GENERALIZED FIELD EQUATIONS AND APPLICATION TO THE DIRAC FIELD. **Datta, B. K. (Univ., Stuttgart). Nuovo Cim.; 6B: No. 1, 16-28(11 Nov 1971).**

This is the continuation of previous work. The action function of matter is supplemented by the action function of a free field. With the help of the usual variational formalism one derives the field equations, which show the correspondence between the canonical energy momentum and Einstein's tensor as well as the correspondence between the canonical spin angular momentum and contorsion. It is shown that these equations are consistent with the conservation laws as derived previously. As a simple example one considers the Dirac field in this formalism. It is shown that spin angular momentum in this case is completely antisymmetric and that the additional terms in the action function arising from torsion express a spin-spin contact interaction. The generalized Dirac equation is shown to be equivalent to a nonlinear spinor equation of Heisenberg-Pauli type in which the nonlinear term is induced by torsion. (auth)

8057 FREE PARTICLE IN A SCALAR–TENSOR UNIVERSE. **Kulhanek, J.; Szamosi, G. (Univ. of Windsor, Ont.). Nuovo Cim.; 6B: No. 1, 46-52(11 Nov 1971).**

The motion of a structureless free particle is considered in a homogeneous isotropic universe in the framework of the scalar-tensor theory. It is shown that the effect of the tensor field in this case does not change the character of the motion as compared with the general-relativistic case. (auth)

8058 INTEGRAL EQUATIONS OF MOTION OF A SYSTEM OF ROTATING BODIES IN THE GENERAL THEORY OF RELATIVITY. **Ryabushko, A. P. (Belorussian Inst. of Agricultural Mechanization, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 3, 70-8(1971). (In Russian).**

In a post-Newtonian approximation there were found ten integral equations of motion belonging to a system of n rotating bodies, and also n integral equations of rotational motion. The feasibility requirement of the law of conservation of moment of momentum of a system (or a summation of Einstein velocities) leads to a unique choice of equations of rotational motion. The results obtained are compared with those of previous work. (tr-auth)

8059 INTERPRETATION OF FIVE-DIMENSIONAL FIELD EQUATIONS. **Bedritskii, A. I. (Vitebsk Pedagogical Inst., USSR). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 3, 79-87(1971). (In Russian).**

On the basis of Lagrange five-dimensional field equations, which describe particles with spins of $\frac{1}{2}$, 1, and $\frac{3}{2}$ in a gravitational field of a three-dimension-time set of de Sitter and the Noether theorem, laws of conservation were established. In addition to the laws of conservation of energy-momentum and field moment of momentum conservation laws were obtained for five momentum components characterized by the field portion of a rest mass and a specially described vector. The interaction of a particle of spin $\frac{1}{2}$ with an electromagnetic field and a weak gravitational field is discussed. Maxwell equations with the D'Alembert wave equations were combined with this five-dimensional covariant relation. The operators of energy, momentum, moment of momentum, spin, magnetic and electrical moments possessed the same interrelations as those associated with the four-dimensional theory (tr-auth)

8060 STUDY OF THE WEYL TENSOR IN A SPACE–TIME CONTAINING A PERFECT FLUID. **Linet, B. (Univ., Paris). Ann. Inst. Henri Poincare, Sect. A; 15: No. 2, 141-51(1971). (In French).**

The relation between the energy-momentum tensor and the Weyl tensor was studied in the following cases: the Weyl tensor is divergence free, the Weyl tensor is of the Petrov N type and/or the perfect fluid is without rotation, or with an equation of state. (France)

8061 EXACT WAVE-TYPE SOLUTION TO f-g THEORY OF GRAVITY. Aichelburg, P. C.; Mansouri, R.; Urbantke, H. K. (Univ., Vienna). Phys. Rev. Lett.; 27: No. 22, 1533-4 (29 Nov 1971).

The well-known plane-fronted waves with parallel rays, exact solutions of the vacuum Einstein gravitational field equations, are generalized to exact solutions of the equations of f-g gravity theory proposed by Isham, Salam, and Strathdee in regions free from matter. (auth)

8062 GENERALIZED PLANE WAVE METRIC. Patel, L. K.; Vaidya, P. C. (Gujarat Univ., India). Ann. Inst. Henri Poincare, Sect. A; 15: No. 2, 169-75(1971).

The Peres metric is generalized in such a way that all the components of the metric tensor g_{ik} become functions of u (u = t − z); some of these components also depend upon x and y coordinates. (France)

8063 GRAVITATION AS A CONSEQUENCE OF THE SELF INTERACTION OF THE GAMMA FIELDS. Novello, Mario (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Notas Fis., Cent. Brasil. Pesqui. Fis.; 16: No. 17, 259-65(1971).

An algebraic-geometry approach to field theory is investigated. An attempt is made to prove that it is possible to understand Einstein's gravitational equation as a consequence of the self interaction of the fundamental Γ-fields of the assumed Clifford algebra. Furthermore, the anti-symmetric object of the algebra obeys a set of equations that has the same structure of Maxwell's equations. (auth)

Scattering Theory

Refer also to abstracts 7909, 7920, and 8019.

8064 FACTORIZATION OF DUAL AMPLITUDES WITH THE AID OF COHERENT STATES OF FIVE-DIMENSIONAL OSCILLATOR AND CLOSED LOOPS. Kvinikhidze, A. N.; Popov, Kh. D.; Stoyanov, D. Tsv.; Tavkhelidze, A. N. (Tbilisi State Univ., USSR. Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 9: No. 2, 190-202(Nov 1971). (In Russian).

In the framework of the coherent states of a finite set of five-dimensional oscillators the factorization of the N-point dual amplitude with respect to the corresponding oscillator operators is revealed. A convergent expression for closed loop is obtained. (auth)

8065 CLASS OF ANALYTIC PERTURBATIONS FOR ONE-BODY SCHROEDINGER HAMILTONIANS. Aguilar, J.; Combes, J. M. (CNRS, Marseille). Commun. Math. Phys.; 22: No. 4, 269-79(1971).

A class of symmetric relatively compact perturbations satisfying analyticity conditions with respect to the dilatation group in R^n is studied. Absence of continuous singular part for the Hamiltonians is proved together with the existence of an absolutely continuous part having spectrum $(0,\infty)$. The point spectrum consists in $\mathrm{IR} - \{0\}$ of finite multiplicity isolated energy bound-states standing in a bounded domain. Bound-state wave functions are analytic with respect to the dilatation group. Some properties of resonance poles are investigated. (auth)

8066 SPECTRAL PROPERTIES OF MANY-BODY SCHROEDINGER OPERATORS WITH DILATATION-ANALYTIC INTERACTIONS. Balslev, E. (SUNY, Buffalo); Combes, J. M. Commun. Math. Phys.; 22: No. 4, 280-94(1971).

Quantum mechanical N-body systems with dilatation analytic interactions are investigated. Absence of a continuous singular part for the Hamiltonians is proved together with the existence of an absolutely continuous part having spectrum (λ_e,∞), where λ_e is the lowest many body threshold of the system. In the complement of the set of thresholds the point spectrum is discrete; corresponding bound state wave-functions are analytic with respect to the dilatation group. (auth)

8067 WAVE OPERATORS FOR CLASSICAL PARTICLE SCATTERING. Simon, Barry (Princeton Univ., N. J.). Commun. Math. Phys.; 23: No. 1, 37-48(1971).

The fundamentals of classical particle scattering of a two body system in forces which are $0(r^{-2-E})$ at infinity along with their Lipshitz constants are discussed. Asymptotic completeness is proven for this two-body case. Of particular interest is the fact that in the absence of control on Lipshitz constants at ∞, two solutions of the interacting equation may be asymptotic to the same free solution at −∞. (auth)

8068 BOUNDS ON SCATTERING AMPLITUDES. Einhorn, Martin B.; Blankenbecler, Richard (Stanford Univ., Calif.). Ann. Phys. (N.Y.); 67: No. 2, 480-517(Oct 1971).

The method of Lagrange multipliers, generalized to include inequality constraints, is used to derive bounds on scattering amplitudes based on unitarity and polynomial behavior. Various physical quantities associated with two-body scattering processes are treated, such as the total cross section, elastic cross section, absorptive part, and real part of the scattering amplitude. These new mathematical techniques are used to treat and generalize several familiar problems. In addition, a number of new results are presented. Both asymptotically large energy bounds and finite energy bounds with no arbitrary constants are given. (auth)

8069 BOUNDS ON THE ABSORPTIVE PART OF ELASTIC SCATTERING AMPLITUDES WITH A MONOTONICITY CONSTRAINT. Feinberg, Shlomo (Tel-Aviv Univ., Israel). Phys. Rev., D; 4: No. 5, 1435-41(1 Sep 1971).

The problem of finding upper and lower bounds for the absorptive part of elastic scattering amplitudes given the total and elastic cross section, unitarity, and a monotonicity constraint on the successive partial waves. The bounds are derived using the generalized Lagrange-multiplier technique due to Blankenbecler and Einhorn. The question of which of the many solutions given by that method should be chosen is investigated in detail and also the physical motivation for the monotonicity assumption is discussed. (auth)

8070 COMPLEX REGGE TRAJECTORIES. Oehme, Reinhard (Univ. of Chicago). Phys. Rev., D; 4: No. 5, 1485-95(1 Sep 1971).

Conditions are explored which require the presence of leading positive- or negative-signature trajectories of the form $\alpha(t) = 1 + \text{const}\,\sqrt{t} + 0(t)$. General forms of continued partial-wave amplitudes with such trajectories are given, and their implications for high-energy limits are evaluated. The restrictions on the character of the complex singular surfaces are discussed. Explicit examples are given for amplitudes with complex Regge trajectories. (auth)

8071 NODE-CUSP DEVELOPMENTS ON LANDAU CURVES II. Cunningham, J. (University Coll. of North Wales, Bangor, Irland). Nucl. Phys.; B35: No. 1, 234-6(1971).

The degree of the leading Landau curve of the Mercedes vertex diagram is determined analytically for certain symmetries among the internal masses and a tentative empirical identification is made. (auth)

8072 DUAL AMPLITUDES FOR CURRENTS. Drummond, I. T. (CERN, Geneva). Nucl. Phys.; B35: No. 1, 269-86(1971).

Dual amplitudes for scalar currents which exhibit consistent factorization properties are constructed. This is true both of internal channels and external legs. However, the spectrum necessary for factorization requires an enlargement of the hadron S-matrix to include more channels than appear in the original Veneziano theory. The "photoproduction" amplitudes have fixed poles in the J-plane as well as Regge poles so FESR of the usual kind cannot be derived. These amplitudes also have interesting behavior in the scaling limit. The photon propagator, however, has a somewhat unsatisfactory structure. (auth)

8073 KIND OF REALISTIC DUAL N-MESON AMPLITUDES. Gonzalez Mestres, L. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys.; B35: No. 1, 189-212(1971).

An algorithm is presented allowing the construction of dual N-meson amplitudes incorporating any kind of linear trajectories. These amplitudes are of the type in which a polynomial modifies the Chan integrand. At the leading level neither degeneracy nor ghosts are present. The degeneracy is finite at any nonleading level but the problem of negative residue ghosts on the nonleading trajectories is somehow worse than for the ordinary N-point B-functions. (auth)

8074 BOUNDS ON MULTICHANNEL SCATTERING PARAMETERS. Zakhariev, B. N. (International Centre for Theoretical Physics, Trieste, Italy); Lkhagva, O.; Niyasgulov, S. A.; Fenin, Y. I. Nuovo Cim.; 6A: No. 2, 151-7(21 Nov 1971).

It is shown that definite bounds on a reaction matrix could be obtained by using the technique of asymptotic separation recently developed for the description of rearrangement collisions and processes above the threshold of the division of the system into three fragments. (auth)

8075 PHENOMENOLOGICAL MODEL OF REGGE CUTS BASED ON THE REGGEON-DIAGRAM TECHNIQUE. QUALITATIVE CONSIDERATIONS. Kobayashi, T. (Tokyo Metropolitan Univ.); Yamagishi, K. Nuovo Cim.; 6A: No. 2, 232-40(21 Nov 1971).

A Regge-cut model which incorporates the Veneziano amplitude extrapolated to off the mass shell in the reggeon-diagram technique is proposed. The cut satisfies Mandelstam's criteria on cut-generating diagrams, and the discontinuity across Regge cuts is parametrized by relatively few free parameters. Qualitative predictions about some high-energy reactions are derived from the assumption of nonexotic resonances and the dominance of leading poles in the Veneziano amplitudes. (auth)

8076 SMOOTHNESS NEAR THE LIGHT-CONE AND SUPERCONVERGENCE. Calucci, G. (Univ., Trieste, Italy. Istituto Nazionale di Fisica Nucleare, Trieste, Italy); Jengo, R.; Furlan, G.; Rebbi, C. Phys. Lett.; 37B: No. 4, 416-19(13 Dec 1971).

It is shown that the derivation of the standard sum rules requires more than the null plane structure of the commutators. The usual form is obtained only for a definite smooth behavior of the current commutator near the light cone, which corresponds to the hypothesis of superconvergence for strong and semistrong amplitudes. (auth)

8077 INVERSE SCATTERING PROBLEM AT FIXED ENERGY FOR THE TENSOR AND SPIN-ORBIT POTENTIALS. Hooshyar, M. A. (Indiana Univ., Bloomington). J. Math. Phys. (N. Y.); 12: No. 10, 2243-58(Oct 1971).

The main purpose is to find an analog of the Regge–Newton equation for the problem of finding tensor and spin–orbit potentials, acting among particles of spin $\frac{1}{2}$, from the knowledge of the S-matrix as a function of angular momentum at a fixed energy. First, a transformation is found which makes the Schroedinger equation containing a central, a spin–orbit, and a tensor potential the matrix analog of the Schroedinger equation for spin-$\frac{1}{2}$ particle in a central and a spin–orbit potential. Next, guided by previous work for the case of central and spin–orbit potentials, one can find the desired integral equation. The necessary existence and uniqueness of the solution to this integral equation is studied, and it is shown that, indeed, the wave functions for tensor and spin–orbit potentials can be represented in terms of the solution of this integral equation. A series representation of the wave functions, which are necessary for finding the potentials from the S matrix, is found; but the actual construction of the potentials from the S matrix is not considered. (auth)

8078 FREUND MODEL FOR POMERANCHUK TERM. Miyamura, Osamu (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 4, 1111-24(Oct 1971).

Freund model for Pomeranchuk term is investigated in the near forward direction. A bootstrap equation is derived from a two-body unitarity equation at high energy for this purpose. The solution in the case that only the contributions of one-sided-quasi-two-body states are included in unitarity sum is discussed in the near forward direction. From the solution the form of differential cross section for quasi-two-body scattering is obtained. It shows the same behavior as that expected from the Veneziano model and leads to an interesting condition for the relation between the intercept of Pomeranchuk trajectory and that of normal Regge trajectory. (auth)

Particle Accelerators

Refer also to abstracts 6847, 6910, 7789, 7872, and 8224.

8079 (BNL-16299) HIGH-FIELD BENDING MAGNET FOR HIGH-ENERGY STORAGE RINGS. Parzen, G.; Jellett, K. (Brookhaven National Lab., Upton, N. Y.). 10 Nov 1971. 10p. Dep. NTIS.

A circular magnet with a cosine current distribution and a 2 in. aperture is proposed which fulfills suggested tolerances for bending magnets in high-energy storage rings while reaching a field of 40 kG. The iron shield can be chosen to keep the higher multipoles in the magnetic field small so that a correction coil is required only for the sextupole term in the magnetic field. (auth)

8080 (BNL-tr-447) AIR-CORE AND IRON-CORE MAGNETS AND LENSES WITH WINDINGS OF FINITE THICKNESS FOR ACCELERATORS. Davidovskii, V. G. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from report IYAF-40-70. 150p. Dep. NTIS.

The results of calculations of the air-core and iron-core conductor magnets that produce a prescribed constant magnetic field in the cylindrical region of circular cross section when windings with a constant current density are used are presented and discussed. Also, methods are suggested for calculating air-core magnets for producing a field in the elliptic and rectangular regions and iron-core conductor magnets for producing a quadrupole field in the rectangular region. (W.H.K.)

8081 (CERN-71-15) COHERENT INSTABILITY DUE TO ELECTRONS IN A COASTING PROTON BEAM. Hereward, H. G. (European Organization for Nuclear Research, Geneva (Switzerland)). 27 Jul 1971. 7p. Dep. NTIS (U. S. Sales Only).

The 40 to 60 MHz betatron mode signals that are seen in the Intersecting Storage Rings and are at about the frequency of electrons oscillating in the potential well of the beam are studied. A model is described with which the thresholds and growth rates of instabilities arising from the interaction between the beam and the oscillating electrons can be estimated. (W.H.K.)

8082 (CERN-71-20) NEW SUPPLY TO CERN PROTON SYNCHROTRON MAGNET. II. DESCRIPTION OF COMPONENTS. Bayard, O. (European Organization for Nuclear Research, Geneva (Switzerland)). 28 Sep 1971. 146p. (In French). Dep. NTIS (U. S. Sales Only).

The details of the new power supply to the CERN proton synchrotron are given. The magnet and its excitation cycles, the rotating group, the conversion stations and the filters, and the apparatus of control, synchronization, and regulation are discussed. (tr-auth)

8083 (IFVE-OP/SPK-70-93) FOCUSING DEVICE FOR THE NEUTRINO EXPERIMENT. Voronov, V. I.; Danil'chenko, I. A.; Rzaev, R. A.; Samoilov, A. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 61p. (In Russian). Dep. NTIS (U. S. Sales Only).

A description of the magneticoptic system that consists of linear-focusing units is given. Proceeding from performed analysis, an optimum system consisting of parabolic lenses has been chosen. This system may be applied in the IHEP neutrino experiments. The calculated ratio and neutrino spectra are given. (auth)

8084 (IFVE-SKU-70-79) SIMULTANEOUS OPERATION OF THE PROTON SLOW AND FAST EJECTION SYSTEMS AT THE IHEP 70-GeV ACCELERATOR. Myznikov, K. P.; Tatarenko, V. M.; Fedotov, Yu. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 34p. (In Russian). Dep. NTIS (U. S. Sales Only).

The operational mode of the simultaneous operation of the fast and slow proton ejection systems of the IHEP accelerator is considered. The influence of the magnetic field correction system, necessary for simultaneous operation, on movement and focusing of the ejected particles is taken into account. The design parameters of the equipment for the ejection and focusing systems are defined, and its location at the accelerator is clarified. (auth)

8085 (INPh-34-70) SUM OF DECREMENTS OF COHERENT OSCILLATIONS IN STORAGE RING. Derbenev, Ya. S.; Dikansky, N. S.; Pestrikov, D. V. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 1970. 46p. Dep. NTIS (U. S. Sales Only).

The basis of the possibility of simultaneous damping of the collective beam oscillations in a storage ring in all oscillating degrees of freedom is presented. The so-called "theorem on the decrement sum" of modes of the beam coherent excitations interacting with the external system is determined. In the general case, in contrast to synchrotron radiation, the decrement sum is not proportional to the full power loss. It is shown also that for the beam interactions with the systems "without memory" the decrement sum in the linear approximation does not depend on the connection of radial and longitudinal motion. This allows the use of such systems for damping synchrotron oscillations simultaneously with the radial ones owing to the decrement redistribution. (auth)

8086 (IYAF-44-70) DYNAMICS OF PARTICLE POLARIZATION NEAR SPIN RESONANCES. Derbenev, Ya. S.; Kondratenko, A. M.; Skrinskii, A. N. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 1970. 38p. (In Russian). Dep. NTIS (U. S. Sales Only).

The influence of particle deviations from the equilibrium orbit on spin motion in the storage ring is investigated. The methods and results of works for the case of an arbitrary closed orbit are generalized. In addition to resonances of the first approximation, the resonances of higher orders are considered. The case of overlapped resonances is also considered. The main part of the work is devoted to resonance crossing. The general solution of the single-crossing problem is given. On this base the periodical crossing problem has been raised and solved using the general character of the spin motion in a periodical field. (auth)

8087 (LA–4795) INVESTIGATION OF GRAPHITE AND CARBON FOR STRIPPING THE H^- BEAM IN LAMPF. Liska, Donald J. (Los Alamos Scientific Lab., N. Mex.). Oct 1971. Contract W-7405-eng-36. 10p. Dep. NTIS.

Calculations indicate that either pyrolytic graphite or pyrolytic carbon are suitable materials for stripping the H^- proton beam with $\leq 10^{-6}$ H^0 contamination at an average current of 300 μA and an average power density of 2.75 W/cm^2. Two methods of manufacture are described, one using a peeling technique suitable for weakly bonded laminar structures such as pyrolytic graphite, and the other a deposition technique using fluidized beds to produce foils of pyrolytic carbon. Pyrolytic graphite foils tested on EPA indicate a minimum of 30 hours of continuous beam without failure. Electron microscope photos of foil surfaces show an absence of physical change due to the beam which leads to the conclusion that the foils might be capable of perhaps a week of continuous beam time. (auth)

8088 (LBL–346) STATUS REPORT ON ERA, BERKELEY. Keefe, D. (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1971. Contract W-7405-eng-48. 7p. (CONF-710908–4). Dep. NTIS.

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The current state of progress in experiments on ERA at Berkeley is reviewed. Experiments on high-current instabilities have been in progress for several months with the newly constructed high-current electron accelerator. The major experimental and theoretical attack at present is addressed to understanding the stabilization of the negative-mass instability, which is limiting the ring quality. Stable rings with 6×10^{12} electrons have been formed but with a larger energy spread than desired. (auth)

8089 (NP–19109) INVESTIGATION OF THE DYNAMICS OF CHARGED PARTICLES IN INTENSIVE BEAMS WITH NON-STATIONARY DISTRIBUTION OF TRANSVERSE PHASE DENSITY WITH THE HELP OF NUMERICAL EXPERIMENTS. Kuznetsov, V. S.; Kuznetsova, N. P.; Fidel'skaya, R. P.; Solnyshkov, A. I. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). 1970. 21p. (In Russian). Dep. NTIS.

The algorithm and calculation scheme of the redistribution of the phase density as applied to an axially-symmetric beam for an arbitrary function of the particle density distribution in transverse coordinates and velocities are discussed. Concrete calculation results of the variation of distribution of the transverse phase density are given when particles of an intense proton beam move in a direct current accelerator and when a charged particle beam moves in a homogeneous magnetic field. Some typical peculiarities of dynamics of intense beams with non-stationary distribution of the transverse phase density and non-linear distribution of Coulomb forces are explained. (auth)

8090 (NP–19110) DERIVATION AND SOLUTION OF THE SYSTEM OF EQUATIONS WHICH DESCRIBE INTENSIVE BEAMS WITH NONSTATIONARY DISTRIBUTION OF TRANSVERSE PHASE DENSITY. Kuznetsov, V. S. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). 1970. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

The system of equations defining the four-dimensional non-stationary function of the particle density distribution over transverse coordinates and velocities depending on the longitudinal coordinates of the beam is derived. The method for numerical solution of the system of equations is given. (auth)

8091 (RHEL/R–227) NIMROD OPERATION AND DEVELOPMENT. Quarterly Report, April 1–June 30, 1971. Gray, D. E. (ed.) (Rutherford High Energy Lab., Chilton (England)). Sep 1971. 11p. Dep. NTIS (U. S. Sales Only). 16p.

The Nimrod beam was on for High Energy Physics Research for 81.1% of HEP scheduled operating time. Two experiments commenced and six continued through this quarter. Some radiation dosimetry measurements in the inner vacuum vessel of Nimrod are presented. (auth)

8092 (UCRL-Trans–1454) RADIATION FROM AN ELECTRON RING AS IT TRAVELS PAST THE JUNCTION OF TWO CIRCULAR WAVEGUIDES. Voskresenskii, G. V.; Kurdyumov, V. N. Translated by B. Thayne for Univ. of California Lawrence Radiation Lab., Berkeley, from Tr. Radiotekh. Inst.; No. 2, 60-76(1970). 16p. Dep. NTIS.

The energy losses due to radiation sustained by a thin electron ring in uniform travel past an elementary nonuniformity in a circular waveguide are calculated. It is shown that the charged ring's losses increase linearly as a function of its energy, while the losses sustained by a current ring increase as the cube of the energy. (auth)

8093 PERFORMANCE OF THE ISR. Keil, E. CERN Cour.; 11: No. 9, 243-7(Sep 1971).

Improvements in hardware and operation are described including rf stacking, the control computer, and the closed orbit correction. New achievements including the transverse instability correction and increased beam currents and lifetimes are discussed. Problems with vacuum pressure bumps, saturation and antistacking, and betatron oscillations are explained. Also, the operating status of the ISR is summarized. (W.H.K.)

8094 LOW VOLTAGE PARTICLE ACCELERATORS FOR NEUTRON GENERATION. Holland, L.; Hawkesworth, M. R. (Univ. of Birmingham, Eng.). Non-Destruct. Test.; 4: No. 5, 330-37(Oct 1971).

The basic design features and operating characteristics of both sealed and pumped low voltage (<500 kV) accelerators for the production of intense neutron sources are summarized. Details of the machines of all the known manufactures are included, and the relevance of the information is briefly discussed. (auth)

8095 DYNAMIC RESPONSE OF A LARGE POWER SYSTEM TO A CYCLIC LOAD PRODUCED BY A NUCLEAR ACCELERATOR. Pinnello, J. A. (Commonwealth Edison Co., Chicago); Van Ness, J. E. IEEE (Inst. Elec. Electron. Eng.), Trans. Power App. Syst.; 90: No. 4, 1856-62(Jul-Aug 1971).

The effect of supplying a cyclic pulsating load to the 200 BeV nuclear accelerator from the 345 KV interconnected power system in Weston, Illinois, is studied. The voltage and frequency fluctuations in the transmission system and the excitation of the resonant modes of the generators with their governors and exciters are obtained. This is the first known case of a large accelerator being supplied from a power system without the use of an intervening motor-generator set. (auth)

8096 HEAVY ION ACCELERATORS OF THE FUTURE. Blann, M. (Univ. of Rochester, N. Y.). Nucl. Instrum. Methods; 97: No. 1, 1-17(1971).

New accelerator projects for the production of beams of very heavy ions are described. Emphasis is placed on those systems which are in operation, under construction, or in an advanced stage of planning. Projects at Orsay, Dubna, Berkeley, and Darmstadt are included in this category. Other possible approaches to the acceleration of such heavy ions are discussed briefly. A summary is given of some of the many fields of research to which beams from these new accelerators may be applied. (auth)

8097 NEW SOURCES OF VERY HIGHLY CHARGED HEAVY IONS. Eninger, J. E. (Royal Inst. of Tech., Stockholm). Nucl. Instrum. Methods; 97: No. 1, 19-27(1971).

The importance of high charge-to-mass ratios in the acceleration of heavy ions is discussed. The performance and limitations of existing heavy ion sources are briefly summarized. A review is given of new ion source concepts proposed for the production of very highly charged heavy ions. These concepts include electron beam sources, laser sources and some other high temperature plasma devices as well as the method of acceleration and stripping. The paper describes the current status of the development work on the novel heavy ion sources. (auth)

8098 ORSAY HEAVY ION ACCELERATOR ALICE. Cabrespine, A.; Lefort, M. (Institut de Physique Nucleaire, Orsay, France). Nucl. Instrum. Methods; 97: No. 1, 29-40 (1971).

ALICE has been designed and constructed at the Institute of Nuclear Physics of Orsay, by a group of engineers (Service Electronique Accélérateurs). For the basic concept of the machine and the studies of the numerous pieces of apparatus, most of the work has been done by C. Bieth, M. P. Bourgarel, R. Gayraud, Ch. Goldstein and E. Martin. ALICE is a hybrid accelerator made of a linac injector connected to an AVF cyclotron. Ions of Z/A larger than 0.08 are supplied by the linac at 1.1 MeV per nucleon, up to Kr^{6+} and Kr^{7+}. These ions are further stripped of electrons in the central area of the cyclotron. Because of the high charge state of the ions after stripping, an energy larger than 5 MeV per nucleon is obtained at the exit of the cyclotron for all ions of mass smaller than A = 90. Firstly, a description is given of the cyclotron: magnetic field, generator, ion source, beam extraction, and actual performance characteristics. Secondly, the linac is briefly described: the injector at 140 kV dc, buncher, wave guide cavity, rf generator, and the main features of the 1 MeV per nucleon beam. The third point deals with the beam transport system and the stripping conditions, the energy resolution and the ion current yields of the machine. A brief account is given of the experimental facilities on the beam lines, particularly those to be used in the search for new heavy elements, i.e. on line mass spectrometer, magnetic analyzer and other experimental devices. (auth)

8099 TALIX: A COMBINATION OF A HELIX LINAC AND A TANDEM AS A CW HEAVY ION ACCELERATOR. **Klein, H.; Herminghaus, H.; Junior, P.; Klabunde, J. (Institut fuer Angewandte Physik, Frankfurt am Main). Nucl. Instrum. Methods; 97: No. 1, 41-9(1971).**

A description of a recent proposal for a cw accelerator capable of producing Br-ions of 5.5 MeV/amu is given. It deals mainly with the helix linac part, of which a short description of its operating principle is included. (auth)

8100 MODIFICATION OF THE BERKELEY HILAC. **Main, R. M. (Univ. of California, Berkeley). Nucl. Instrum. Methods; 97: No. 1, 51-64(1971).**

A program is presently in progress for the modification of the Hilac to make possible the acceleration of ions of all masses to a maximum energy of 8.5 MeV/N. Present scheduling calls for the shut down of the existing Hilac in January 1971 and first beams from the modified system in August 1971. The improved accelerator will consist of a pressurized 2.5 MV Cockcroft–Walton injecting ions of minimum charge-to-mass ratio $\epsilon = 0.045$, at 0.112 MeV/N into an Alvarez linac. The linac will be separated at 1.2 MeV/N where particles will be stripped to a minimum $\epsilon = 0.16$. The second linac section will be partitioned into individual cavities of approximately equal velocity increments. Adjustments of rf phase and gradient in these cavities will provide variable energy from 2.6 to 8.5 MeV/N. All cavities will operate at 70.2 MHz and magnetic quadrupole focusing will be used throughout. (auth)

8101 INDIANA UNIVERSITY CYCLOTRON FACILITY. **Rickey, M. E.; Sampson, M. B. (Indiana Univ., Bloomington). Nucl. Instrum. Methods; 97: No. 1, 65-70(1971).**

Indiana University is presently constructing a large variable energy isochronous cyclotron capable of accelerating protons to a maximum energy of 200 MeV, ^{3}He to $\approx$360 MeV, and other ions for which $\frac{1}{8} \leq Q/A \leq \frac{1}{2}$ to maximum energies of $\approx$280 Q^2/A MeV. The accelerator, its laboratory, initial heavy ion capabilities, and possible future improvements are described. (auth)

8102 RISE TIME OF THE MULTIPACTORING PROCESS IN CAVITIES OF PARTICLE ACCELERATORS. **Bischof, B. (Schweizerisches Institut fuer Nuklearforschung, Zurich). Nucl. Instrum. Methods; 97: No. 1, 81-6(1971).**

Multipacting may occur under certain conditions in a rectangular cavity. The multipacting current due to oscillating electrons increases very rapidly because of electron multiplication on the cavity walls. This current produces a heavy load on the rf generator, thus reducing the cavity voltage and, in some cases, it is impossible to reach the operating voltage. By using the theory of a parallel resonant circuit with time-dependent current load the equations for the cavity voltage are developed. From these equations conditions are derived, which allow to calculate the needed rate of rise of the cavity voltage to overcome this multipacting-effect. (auth)

8103 CALCULATION OF THE ION BEAM AXIS IN INCLINED FIELD TUBES WITH EQUAL MAXIMUM DISPLACEMENTS OF THE BEAM. **Kostka, P. (Central Research Inst. for Physics, Budapest). Nucl. Instrum. Methods; 97: No. 1, 87-90(1971).**

A calculation using simple formulae is presented for the determination of the beam axis in inclined field tubes composed of N sections in which the maximum displacements of the curved axis are equal. A nomogram for the determination of the individual section lengths is given. The results are only slightly different from those obtained by more precise computation and the applicability of the calculation has been proved on the tube of the 5 MeV Van de Graaff generator of the Institute. (auth)

8104 PRIMARY STABILIZATION OF A 1 MeV ELECTRON ACCELERATOR. **Bernstein, T. (Univ. of Wisconsin, Madison); Hunter, J. H.; Stichman, J. H. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 2, 19-26(Apr 1969).**

To achieve a resolution on the order of 1 to 5 Å in an electron microscope, accelerating voltage must be stable to approximately 3 parts per million. To achieve these resolutions, a highly stabilized 1 MeV linear electron accelerator was developed. One of its two 15 in. (38 cm) accelerating tubes will provide a velocity stabilized electron beam source for a high resolution electron microscope. Electron acceleration occurs through a constant potential divider. A Van de Graaff type charge carrying pellet string provides the accelerating voltage. The primary or coarse control system for the linear electron accelerator compares the high voltage terminal voltage as detected with an accurate voltage divider to a reference cell voltage. Error signals are amplified to control the voltage on a capacitive liner. Control is accomplished by a voltage control of the cylindrical capacitive liner surrounding the high voltage terminal. The low frequency fluctuations in accelerator voltage maintained by this primary loop are less than 0.1% to permit utilization of a fine control loop with a spectrometer beam analysis control to achieve fine voltage stability of 3 parts per million. (auth)

8105 CURRENT TRANSFORMER AND GATED INTEGRATOR FOR MEASUREMENT OF WEAK CURRENTS FROM PULSED ACCELERATORS. **Feist, H.; Koep, M.; Reich, H. (Physikalisch-Technische Bundesanstalt, Brunswick). Nucl. Instrum. Methods; 97: No. 2, 319-21(1971).**

A non-intercepting beam current monitor and a gated integrator are described which allow to measure peak currents down to about 1 μA from the PTB 5.8 MeV microtron. The monitor differs from similar circuits by using only one winding on a mu-metal core and by a special current–voltage converter of 40 mΩ input impedance. (auth)

8106 BEAM ENERGY MEASUREMENTS AT THE HAMBURG ISOCHRONOUS CYCLOTRON BY A TIME-OF-FLIGHT METHOD. **Langkau, R.; Roesler, H. (Univ., Hamburg). Nucl. Instrum. Methods; 97: No. 2, 413-15(1971). (In German).**

Measurements of cyclotron beam energies by the time-of-flight method are briefly described. (auth)

8107 METHOD OF MATCHING THE EXTERNAL BEAM OF A CYCLOTRON TO AN ION-OPTICAL AXIS. **Schutte, F.; Ehrnreich, K. R.; van Heusden, G. C. L. (Eindhoven Univ. of Tech., Netherlands). Nucl. Instrum. Methods; 97: No. 2, 347-57(1971).**

An iterative method is shown for matching the external beam of the Eindhoven University of Technology AVF-cyclotron to an ion-optical axis. For this purpose the dependence of the horizontal beam position at several locations in the beam transport system with respect to a number of cyclotron parameters has been measured as a function of beam energy. The method used for determining the beam position is discussed. It is demonstrated that the choice of cyclotron parameters and locations in the beam transport system, where the beam position is to be determined, may lead to a non-converging iterative process. However, by choosing the proper parameters and locations the systems acts in such a converging way that within a few iterations the beam can be positioned with an accuracy of better than 0.2 mm. (auth)

8108 FIELD DISTRIBUTION IN A CENTRALLY LOADED CIRCULAR CYLINDRICAL CAVITY. **Bhartia, P.; Hamid, M. A. K. (Univ. of Manitoba, Winnipeg). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 2, 27-34(Apr 1969).**

To accelerate protons in an Alvarez type linear accelerator or electrons in velocity modulated tubes, the cavity must be excited in the dominant TM_{010} mode. For proper understanding of beam dynamics and for purposes of design, the rf fields must be computed accurately for any specified dimensions of the drift space. The exact numerical solution for the fields in a drift tube loaded linear accelerator cavity with a beam guiding hole is presented. The eigenvalues, field distribution, transit time factor and the shunt impedance are formulated everywhere by boundary value techniques in the same manner as proposed by Bolle and Gluckstern in the absence of the beam guiding hole. The numerical results are obtained with the aid of a digital computer and are established by an excellent agreement with an experiment based on perturbation techniques. (auth)

8109 POLARIZATION ANALYSER FOR MEDIUM ENERGY ^{3}He PARTICLES. **Clarke, N. M. (King's Coll., London). Nucl. Instrum. Methods; 97: No. 2, 399-403(1971).**

A polarization analyser for ^{3}He particles in the energy range 20 to 50 MeV has been designed to replace the normal detectors in an existing scattering chamber. Its construction is described and results are presented for calculations of the expected resolution and efficiency. (auth)

8110 PRE-INJECTION e/m ANALYSER SYSTEM FOR USE WITH VAN DE GRAAFF ION SOURCES. **Misra, S. N.; Dwarkanath, M. R. (Bhabha Atomic Research Centre, Bombay). pp 507-11 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).**

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

8111 MEASUREMENT OF MAGNETIC FIELD INDEX n OF THE 5 MeV BETATRON BY AN A. C. POTENTIOMETER. **Bhiday, M. R.; Bhoraskar, V. N. (Univ. of Poona, India). pp 539-44 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).**

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

8112 HIGH CURRENT ELECTRON IMPACT ION SOURCE. **Hui, A. K.; Ghosh, P. K. (Indian Inst. of Tech., Kanpur). pp 567-**

72 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

8113 CHARACTERISTICS OF A DUOPLASMATRON ION SOURCE. Mukherjee, D. K.; Bhattacharya, R. S. (Saha Inst. of Nuclear Physics, Calcutta). pp 573-8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

8114 DESIGN OF A CONTROLLED ν_z SECTOR FOCUSSED ISOCHRONOUS CYCLOTRON FOR MESON FACTORIES. Jain, A.; Divatia, A. S. (Bhabha Atomic Research Centre, Bombay). pp 579-84 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

8115 ION OPTICS IN THE BEAM TRANSPORT SYSTEM OF THE VARIABLE ENERGY CYCLOTRON AT CALCUTTA. Jain, A.; Divatia, A. S. (Bhabha Atomic Research Centre, Bombay). pp 585-90 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

8116 MAGNETIC FIELD MEASUREMENTS IN A 30 CM. AVF MODEL MAGNET. Bhandari, R. K.; Bhattacharya, N. C.; Divatia, A. S.; Jain, A.; Bhattacharjee, B. B. (Bhabha Atomic Research Centre, Bombay). pp 591-6 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

8117 FIRST HARMONIC CONTENT IN THE MAGNETIC FIELD OF AN AVF CYCLOTRON DUE TO CONSTRUCTURAL ERRORS. Jain, A.; Divatia, A. S. (Bhabha Atomic Research Centre, Bombay). pp 597-600 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

8118 PRODUCTION OF PULSED PARTICLE BEAMS BY PHOTODETACHMENT OF H^-. Bryant, H. C. (Univ. of New Mexico, Albuquerque); Lovoi, P. A.; Ohlsen, Gerald G. Phys. Rev. Lett; 27: No. 24, 1628-31(13 Dec 1971).

Photodetachment of electrons from an H^- beam by means of a Q-switched Nd laser can produce a pulsed H^0 beam. H^0 pulses of 20 to 40 nsec were produced with nearly 100% efficiency. The technique is proposed for selection of single micropulses (1/4 nsec) at the Los Alamos Meson Physics Facility for use in a high-resolution time-of-flight system, and is of potential usefulness for other negative-ion accelerators. (auth)

8119 IMPROVEMENTS IN CYCLOTRONS. (to Thomson-CSF). British Patent 1,252,357. 3 Nov 1971. Priority date 22 Nov 1968, France.

A cyclotron composed of at least two dees and two grounded electrodes, where the dees are electrically coupled by an auxiliary electrode, is described. (W.H.K.)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 6578, 6585, 6858, 7692, 7756, 8094, 8322, and 8594.

8120 NEUTRON DIFFUSION FROM A FAST POINT SOURCE IN AQUEOUS ABSORBING SOLUTIONS. Nguyen, Dong H.; Slayton, Marshall T.; Frew, John A. (Naval Postgraduate School, Monterey, Calif.). Nucl. Sci. Eng.; 46: No. 3, 416-21(Dec 1971).

Transport parameters (migration area, age to indium resonance) of fast neutrons from a plutonium-beryllium source were measured in aqueous absorbing solutions at several temperatures (35, 40, 55, and 75°C), using boric acid as the 1/v absorber. For the measurements at 35 and 40°C, the saturation concentrations of boric acid were attained at 70 and 80 g/liter, respectively. For a 1/v absorber, a temperature-dependent power series representation of κ^2 in terms of absorption cross section Σ_{ao} was proposed, based on the concept of neutron temperature. The temperature range wherein such an expansion remains valid was experimentally determined. It was found that strong concentrations of a 1/v absorber caused much difficulty in experimentally resolving the thermal neutron spatial distributions, an observation which might have a direct relation to the $(\Sigma_t)_{min}$ limit of Corngold. (auth)

8121 PYROLYTIC GRAPHITE AS A SELECTIVE NEUTRON FILTER. Pinto, H.; Shaked, H. (Nuclear Research Centre, Beersheva, Israel). Nucl. Instrum. Methods; 97: No. 1, 71-4 (1971).

The transmission of neutrons through pyrolytic graphite with an angular spread of c axes of 3.5° was measured as a function of neutron wavelength. The transmission of first order ($\lambda \approx 2.4$ Å) and attenuation of second order ($\lambda \approx 1.2$ Å) neutrons obtained with this material are better than those obtained by Loopstra which used pyrolytic graphite with an angular spread of 5°. (auth)

8122 METHOD FOR PRODUCING MONOENERGETIC NEUTRONS AT KILOVOLT ENERGIES. Binney, S. E.; Amster, H.; Henninger, R. J.; Mark, H. (Univ. of California, Berkeley). Nucl. Instrum. Methods; 97: No. 1, 139-43(1971).

A new method for producing neutrons in the keV energy region utilizes gamma rays from the radioactive decay of a single isotope to induce the ^{9}Be(γ,n) reaction. The neutrons have as many different energies as there are gamma ray energies above the 1.665 MeV threshold energy of this reaction. For the gamma ray emitters chosen, the neutrons were nearly monoenergetic, although sometimes bienergetic. The gamma ray emitters were steadily formed by neutron activation in an aqueous solution circulated through a nuclear reactor. After leaving an irradiation reservoir near the reactor core, the activated solution flowed over the exterior surface of a thin spherical shell of beryllium, where the photoneutrons were produced. Near the center of the shell, the neutron flux was nearly time-independent and isotropic; the effects of multiple scatterings by all materials were calculated by a one-dimensional multigroup transport code. In order to generate a variety of neutron spectra, the sulfates of manganese, indium, and aluminum were used in separate experiments. Fluxes of the order of 10^4 to 10^6 n/cm^2 s can be obtained by this method. (auth)

8123 NEUTRON SCATTERING FROM LIQUID HELIUM AT LARGE MOMENTUM TRANSFER. Sunakawa, Sigenobu; Okajima, Kazuo; Matsuda, Kiyohisa (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 1, 354-6(Jul 1971).

A simple model is proposed to account for the features of the neutron scattering cross section for liquid helium at large momentum transfer. The theory is based on the idea that the scattered helium atom recoiling with higher speed than the speed of sound in liquid helium gives rise to phonons. This new channel may give an increase in the width of the cross section. The theory is compared with experimental data. (J.W.R.)

8124 SEALED TUBE PULSE NEUTRON GENERATORS. Faure, C. (CEA, Villeneuve-Saint-Georges, France). Acta Electron.; 13: No. 4, 317-64(Oct 1970). (In French).

The working principles of pulse neutron generators in sealed tubes are examined. The first problem discussed is that of targets, their impregnation with tritium, the calculation of neutron yield and the creation of neutron pulses. The physical phenomena such as space charge effects or breakdown were investigated to determine the electrical working characteristics and the best performances to be expected; a general review of the different possibilities is presented, especially for the choice of ion sources. Two kinds of tubes were carefully investigated: adsorbed gas tubes and high voltage discharge tubes. (auth)

8125 NEUTRON GENERATORS. Eschard, G. (Laboratoires d'Electronique et de Physique Appliquee, Limeil-Brevannes, France). Acta Electron.; 13: No. 4, 293-303(Oct 1970). (In French).

Neutron sources can be divided into three categories: nuclear reactors, radioactive sources and accelerators, which include sealed-off neutron generators; three examples of the use of neutron generators were selected: activation analysis, neutron radiography and petroleum logging. These methods are already in use throughout industry. (France)

8126 NEUTRON YIELD IN SEALED-OFF ACCELERATORS. Ab, Z. A.; Khutsishbili, L. A. Geofiz. App.; No. 44, 148-50(1970). (In Russian).

The specific neutron yield of sealed-off portable accelerators is small (10^6 n/μcoulomb) as compared with the value of 10^8 commonly obtained under optimal conditions with a d + T reaction. Since gaseous tritium was not available, experiments were conducted with the d + D reaction. Construction of the tube, voltages and currents used, and its conditioning by heating and pumping (10^{-7} mm Hg) are described in some detail, which eventually lead to a stable operation of 5.4×10^6 n/sec, corresponding to a yield with the d + T reaction of 5×10^8 n/sec. (K.S.W.)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 7767, 7787, 7977, 7993, 7995, and 8318.

8127 (COO-1265-113) EXCHANGE EFFECTS IN ^{3}He + ^{4}He SCATTERING. Tang, Y. C. (Tuebingen Univ. (West Germany). Institut fuer Theoretische Physik. Minnesota Univ., Minneapolis. School of Physics); Brown, Ronald E. (Minnesota Univ., Minneapolis. School of Physics). [1971]. 20p. Dep. NTIS.

The elastic scattering of ^{3}He by ^{4}He at 44.5 MeV (c.m.) is considered within the resonating-group formalism. The existence of open reaction channels is taken into account approximately by the introduction of a phenomenological, local, imaginary potential into the usual resonating-group formulation of the scattering problem. By choosing the shape and strength of this potential in a reasonable manner, it is found that a fairly good fit to the experimental differential cross section can be obtained in both the forward and the backward direction. From this study it is also found that the contribution to the differential cross section at backward angles comes mainly from exchange processes, which are contained in the resonating-group formalism through the use of a totally antisymmetrized wave function. The real part of the phase shift is found to have a distinct odd–even feature; and from this it is shown that, if one wishes to describe the experimental scattering data by using a complex, local potential, then the real part of this potential must have a significant amount of Majorana space-exchange component. (auth)

8128 (CO–1265-114) IMAGINARY POTENTIAL IN RESONATING-GROUP CALCULATION OF ^{3}He + ^{3}He SCATTERING. Brown, Ronald E.; Reichstein, I. (Minnesota Univ., Minneapolis. School of Physics); Tang, Y. C. (Tuebingen Univ. (West Germany). Institut fuer Theoretische Physik. Minnesota Univ., Minneapolis. School of Physics). [1971]. Contracts AT(11-1)-1764; AT(11-1)-1265. 17p. Dep. NTIS.

The ^{3}He + ^{3}He differential scattering and reaction cross section data in the energy range of 1.5 to 15 MeV (c.m.) is analyzed with a one-channel resonating-group method to which is added a phenomenological imaginary potential in order to account approximately for open reaction channels. With a nucleon–nucleon potential of near-Serber exchange mixture it is found that satisfactory results can be obtained with such a formalism. The presence of the imaginary potential is shown to be important, especially at higher energies; it mainly affects the magnitude of the differential cross section, but it can also accentuate the diffraction feature at certain energies. (auth)

8129 (LYCEN-7128) QUASI-ELASTIC SCATTERING d + d $\rightarrow$ d + n + p AT 28 MeV. Cabrillat, Jean-Claude (Lyon Univ. (France). Institut de Physique Nucleaire). Jun 1971. 40p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Lyon Univ. (France).

The d + d → d + n + p quasi-elastic scattering reaction was studied kinematically at 28 MeV. The experimental kinematic conditions were determined in an attempt to discover the minimum energy of the spectator particle. A triply differential expression for the cross section is given which takes into account the impulse approximation phenomenon. This approximation does not quantitatively explain the spectra obtained. Nevertheless, the reaction mechanism envisaged leads to a three-body cross section correctly modulated by the free n–d scattering. The problems posed by the coincidence detection of the neutron and the deuteron and by the determination of the neutron detector efficiency are emphasized. (France)

8130 SUM RULE PHOTO-DISINTEGRATION CROSS SECTIONS FOR THE DEUTERON WITH VELOCITY-DEPENDENT AND HARD-CORE POTENTIALS. Raghavan, S. S. (Indian Inst. of Tech., Kharagpur); Srivastava, B. K. Can. J. Phys.; 49: 2211-14(1 Sep 1971).

The sum rules of Levinger and Bethe are used to calculate the integrated cross section and the bremsstrahlung-weighted cross section for the deuteron in the dipole approximation. Nestor's velocity-dependent potential and Reid's hard-core potential were used. The results for σ_{int} and σ_b obtained with the velocity-dependent potential of Nestor and the hard-core potential of Reid agree well with experiments. (auth) (Canada)

8131 VARIATIONAL CALCULATIONS ON A SIMPLE TRITON MODEL USING A COMPLETE HYPERSPHERICAL FUNCTION BASIS. Erens, G.; Visschers, J. L.; van Wageningen, R. (Vrije Univ., Amsterdam). Ann. Phys. (N. Y.); 67: No. 2, 461-79(Oct 1971).

Variational calculations performed for the three-boson model of the triton are reported. The trial function is constructed using a denumerable, complete, and orthonormal set of functions. Each of these functions is the product of a hyperspherical harmonic and a hyperradial function. This leads to a standard matrix eigenvalue problem. Various forms for the radial dependence of the two-particle interaction, with and without repulsion near the origin, and with and without a 1/r singularity in the origin, are investigated. By using a particular set of hyperspherical harmonics and introducing a new set of hyperradial functions, a considerable improvement is achieved as compared with other calculations using hyperspherical function bases. The results also compare favorably with those obtained using different methods or other types of trial functions. From this comparison and by investigating the convergence of the energy and of the trial function, it is found that the quality of the results ranges from excellent for the simplest interactions to acceptable for the more sophisticated ones. A few results of physical interest are given. (auth)

8132 PHOTODISINTEGRATION OF THE ALPHA PARTICLE. Yadav, H. L.; Mahanti, D.; Srivastava, B. K. (Indian Inst. of Tech., Kharagpur). pp 125-8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

8133 RESONATING-GROUP STUDY OF FEW NUCLEON SCATTERING PROBLEMS. Reichstein, Irwin. Minneapolis; Univ. of Minnesota (1970). 205p. University Microfilms Order No. 71-18,807.

Thesis.

Several scattering problems involving few-nucleon systems are studied using the Resonating-Group method in the one-channel approximation. The Resonating-Group method employs a nucleon–nucleon potential together with an appropriate totally antisymmetrized wave function, which is chosen according to considerations of the cluster model. A variational calculation is then performed leading to an integro-differential equation for the scattering wave function. This equation is solved numerically using the C.D.C 6600 computer and the scattering wave function is obtained. From the scattering wave function, cross sections, polarizations and rotation parameters are computed. The nucleon–nucleon potential used yields correct values for the effective-range parameters of the two-nucleon scattering problem. This potential is used in the study of $\alpha + \alpha$, α + N, p + ^{3}He and n + ^{3}H systems. In addition, a phenomenological two-body spin-orbit term is added in the study of the α + N case to account for the splitting observed in the scattering phase shifts. Using the calculated scattering functions, effective potentials between the target and projectile nuclei are constructed. These effective potentials are studied to learn their salient features. From the study of a number of such cases it is hoped that one could construct such potentials in cases where a direct application of the resonating-group method is not feasible. (Diss. Abstr. Int., B)

8134 TREIMAN–YANG CRITERION FOR QUASIFREE SCATTERING IN DEUTERON BREAKUP AT LOW ENERGY. Corfu, R. (Univ., Neuchatel, Switzerland); Egger, J.-P.; Lunke, C.; (and others). Phys. Rev. Lett; 27: No. 24, 1661-4(13 Dec 1971).

The Treiman–Yang criterion to test the dominance of the pole graph is applied to the reaction H(d,2p)n in the quasi-free condition at a deuteron energy of 20 MeV. The distribution obtained is not constant, this result indicating the need for further graphs. (auth)

8135 IMPULSE APPROXIMATION AND LOW-ENERGY DEUTERON BREAKUP. Petersen, E. L.; Allas, R. G.; Bondelid, R. O.; (and others). (Naval Research Lab., Washington, D. C.). Phys. Rev. Lett.; 27: No. 21, 1454-6(22 Nov 1971).

The angular variations of the D(p,pn)p and D(p,pp)n quasi-elastic scattering processes at E_{inc} = 22.8 MeV are investigated. It is shown that the D(p,pn)p data are incompatible with the simple impulse approximation and with models that include final-state interaction corrections to the simple impulse approximation. The behavior of the ratio of the D(p,pn)p and D(p,pp)n cross sections as a function of angle cannot be explained in terms of any simple model. (auth)

8136 KINEMATICALLY COMPLETE INVESTIGATION OF T = 0 EXCITED STATES OF ^{4}He BY INELASTIC SCATTERING OF α-PARTICLES ON ^{4}He. Haase, E. L.; Wang, W. N.; Fawzi, M. A. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Phys.; A172: No. 1, 81-98(1971).

Using 104 MeV α-particles, coincidence measurements were carried out for the following reactions: $^4He(\alpha,\alpha' t)^1H$, $^4He(\alpha,\alpha' {}^3He)n$ and $^4He(\alpha,\alpha' d)^2H$. In measuring the correlations, the detector of the inelastic α-particle was kept at a fixed position and the second detector scanned over a range of coplanar angles favoring ^{4}He final-state interactions. The data can be fitted consistently with five T = 0 excited states of ^{4}He, at 20.2 MeV, 21.9 MeV, 25.5 MeV, 28.5 MeV and 31.8 MeV with widths (Γ) of 0.2 MeV, 1.8 MeV, 2.9 MeV, 5.3 MeV and 5.6 MeV, respectively. The validity of the sequential reaction mechanism is examined. The internal consistency of the level parameters for the three decay channels as well as the symmetry of the extracted angular correlations about 0 and 90° in the recoil c.m. system agree very well with the model of sequential decay. The angular correlations agree well with the predictions of a simple theory using the impulse approximation. (auth)

8137 ELASTIC SCATTERING OF PROTONS BY DEUTERIUM BETWEEN 15 AND 20 MeV. Cahill, T. A. (Univ. of California, Davis); Greenwood, J.; Willmes, H.; Shadoan, D. J. Phys. Rev., C; 4: No. 5, 1499-1504(Nov 1971).

Differential cross sections for elastic scattering of protons by deuterium were measured at laboratory energies of 14.9, 15.5, 16.2, 17.1, 18.5, 19.0, 19.6, and 19.9 MeV. Seventeen angles between 21.8 and 150.9° cm were included in each distribution. Nine of the angles represent the zeros of the Legendre polynomials through l = 4. Relative errors were about 0.8% on the average, and absolute errors were about 1.8%. In addition, relative angular distributions were taken at 16.2, 17.1, 18.5, and 19.1 MeV, including 51 angles between 9.8 and 167.0°cm. These were normalized to the absolute data at cm angles between 30 and 54° and are in good agreement at the remaining angles. Smooth curves can be drawn through the data, and no indications of strong resonant behavior are found in this energy range. (auth)

8138 $^3He(^3He,2p)^4He$ TOTAL CROSS-SECTION MEASUREMENTS BELOW THE COULOMB BARRIER. Dwarakanath, M. R.; Winkler, H. (California Inst. of Tech., Pasadena). Phys. Rev., C; 4: No. 5, 1532-40(Nov 1971).

Measurements of cross sections for $^3He(^3He,2p)^4He$ were made for center-of-momentum energies between 80 keV and 1.1 MeV. A continuously recirculating differentially pumped gas target system was employed to minimize uncertainties in energy loss and straggling. A calorimetric device was used to integrate the beam current within the target gas. Proton angular distributions were measured at seven energies. The measured cross-section factor, S(E), was fitted to a linear function of energy for E_{cm} < 500 keV: $S(E_{cm}) = S_0 + S'_0E_{cm}$, where $S_0 = (5.0^{+0.6}_{-0.4})$ MeV-b and $s'_0 = (-1.8 \pm 0.5)$ b. The formula $S(E_{cm}) = S_0 + S_0E_{cm} + \frac{1}{2}S''_0E^2_{cm}$, with S_0 = 5.2 MeV-b, $S'_0 = -2.8$ b, and S''_0 = 2.4 b MeV^{-1} gives a good representation of S(E) over the entire range of energies studied. (auth)

8139 PROTON–PROTON BREMSSTRAHLUNG MEASUREMENTS AT 20 MeV. Storm, Derek W.; Heffner, R. (Univ. of Washington, Seattle). Phys. Rev., C; 4: No. 5, 1541-51(Nov 1971).

The proton–proton bremsstrahlung cross section, $d\sigma/d\Omega_1 d\Omega_2$, was measured at 20 MeV incident proton energy by detecting coincident protons at 25° and at 30° on either side of the beam. In addition, the photon angular distributions, $d\sigma/d\Omega_1 d\Omega_2 d\theta_\gamma$, were determined. The value measured for $d\sigma/d\Omega_1 d\Omega_2$ for proton angles of 25° is 0.68 ± 0.07 μb/sr^2, while that for 30° is 0.69 ± 0.07 μb/sr^2. These results are for coplanar geometry and are determined from the data by using the azimuthal angular dependence for the cross section predicted by Drechsel and Maximon [Ann. Phys. (N.Y.), 49: 403(1968)]. The results agree with the predictions of Marker and Signell [Phys. Rev. 185: 1286(1969)], when Coulomb corrections are included. (auth)

8140 QUASIFREE p–p SCATTERING IN THE REACTION ^{2}H(p,2p)n FROM 21.5 TO 56.4 MeV. Durand, J. L.; Arvieux, J.; Fiore, A.; Perrin, Cl. (Institut des Science Nucleaires, Grenoble, France). Phys. Rev., C; 4: No. 5, 1957-9(Nov 1971).

Quasi-free p–p scattering was studied in the reaction ^{2}H(p,2p)n between 21.5 and 56.4 MeV. Results are fitted with simple impulse-approximation models, which reproduce the position and shape of the quasi-free peak but give too high an absolute value for the cross section. (auth)

8141 SIMPLE NEUTRON-TRANSFER MODEL FOR THE EXCHANGE RESONANCE IN ^{3}He–^{4}He ELASTIC SCATTERING. Fuller, R. C. (Instituto Politecnico Nacional, Mexico City). Phys. Rev., C; 4: No. 5, 1968-71(Nov 1971).

A simple model based on summing neutron-transfer diagrams is developed. This model gives a broad peak in the backward ^{3}He–^{4}He elastic scattering cross section having some of the observed characteristics. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 7767, 7787, 7974, 8224, 8229, 8300, 8316–8318, 8331, and 8364.

8142 (COO–1265–106) (p,t) AND (p,^{3}He) REACTIONS ON ^{17}O AT 39.8 MeV. Olsen, David K.; Brown, Ronald E. (Minnesota Univ., Minneapolis. John H. Williams Lab. of Nuclear Physics). [1970]. 28p. Dep. NTIS.

Differential cross sections were measured at forward angles for (p,t) and (p,^{3}He) transitions from ^{17}O to the $\frac{1}{2}^-$ ground states and lowest-energy $\frac{3}{2}^-$ states in the ^{15}O and ^{15}N mirror nuclei. The data are compared with DWBA calculations using simple single-particle and single-hole wave functions. When the (p,t) and (p,^{3}He) transitions are considered separately, the calculated and experimental ratios of the $\frac{3}{2}^-$ integrated cross sections to the $\frac{1}{2}^-$ integrated cross sections agree to within 30%; however, the ratios of (p,^{3}He) cross sections to the mirror state (p,t) cross sections are calculated to be about twice as large as actually measured. This experimentally observed reduction of the (p,^{3}He) reaction relative to the (p,t) reaction can possibly be attributed to interference between the S = 0 and S = 1 components of the (p,^{3}He) transitions. (auth)

8143 (LYCEN–7134) STUDY OF QUASI-ELASTIC SCATTERING EXPERIMENTS ON LIGHT NUCLEI. Chevallier, Michel (Lyon Univ. (France). Institut de Physique Nucleaire). Jun 1971. 39p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Lyon Univ. (France).

The reactions ^{6}Li(α,2α)d at 42.8 MeV, ^{9}Be(α,2α)^{5}He at 42.8 and 49.2 MeV, ^{16}O(α,2α)^{12}C at 46 and 52.5 MeV, ^{19}F(α,2α)^{15}N and ^{19}F(α,αt)^{16}O at 60.2 MeV were studied. The angular distributions and energy distributions were analyzed. The plane-wave impulse approximation and the approximation of the off-shell (α,α) scattering cross section using the on-shell cross section are valid for the ^{6}Li(α,2α)d reaction only. For the other nuclei, the shape of the (α,α) cross section, especially the 20-MeV resonance, reappears. The off-shell (α,γ) cross section is not very different from this cross section in the final state. The number of clusters depends on the form of the analytical expression for the function describing their relative motion. For α substructures, the number of clusters varies from 0.21 for ^{6}Li to 0.04 for ^{19}F. A comparison between ^{19}F(α,2α) and ^{19}F(α,αt) cross sections demonstrates that the (^{16}O + triton) configuration is no more likely than the (^{15}N + α) configuration, contrary to certain previous theoretical predictions. (France)

8144 HIGH ENERGY REACTIONS AND SHELL MODEL WAVEFUNCTIONS OF ^{7}Li. Ramachandran, G. (Indian Statistical Inst., Calcutta). pp 85-9 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

8145 STUDY OF THE TWO HOLE STATES IN ^{12}C NUCLEUS WITH THE (π^-,nn) REACTION. Jain, B. K. (Bhabha Atomic Research Centre, Bombay). pp 129-35 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

8146 TRITON KNOCK-OUT FROM ^{7}Li NUCLEUS. Jain, A. K.; Sarma, N. (Bhabha Atomic Research Centre, Bombay). pp 137-9 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

8147 ANALYSIS OF (p,2p) AND (e,e'p) REACTIONS ON ^{12}C NUCLEUS. Shanta, R.; Jain, B. K. (Bhabha Atomic Research Centre, Trombay, India). pp 143-8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

8148 DUAL CORE MODEL FOR ^{10}B NUCLEUS. Narayana, K. L.; Desai, Shamrao B. (Shivaji Univ., Kolhapur, India). pp 227-30 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

8149 GROUND STATE ENERGIES OF DOUBLY EVEN NUCLEI ($12 \leq A \leq 40$). Khanna, K. M. (Dibrugarh Univ., India); Sharma, M. L. pp 301-5 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

8150 STATES OF ^{8}Be FROM THE ANALYSIS OF ^{7}Li(p,α)^{4}He REACTION DATA. Kumar, N. (Indian Inst. of Tech., Kanpur); Barker, F. C. pp 653-8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

8151 PRODUCTION OF ^{7}Be FROM LIGHT TARGETS BY 30 MeV TO 24 GeV PROTONS. Barbier, M.; Regnier, S. (European Organization for Nuclear Research, Geneva). J. Inorg. Nucl. Chem.; 33: No. 8, 2720-2(Aug 1971).

^{7}Be production cross-sections were measured in Be at 30, 50, 160, 300, 600 MeV, 10 and 24 GeV, in B at 300 and 600 MeV, and in N at 300 and 600 MeV. ^{9}Be, B_4C and BN targets were irradiated at 30 and 50 MeV, in the synchrocyclotron at 160, 300 and 600 MeV and in the proton synchrotron at 10 and 24 GeV. Over a period of 53 days, ^{7}Be, by electron capture changes into ^{7}Li in an excited state leading to the emission of γ-radiation of 0.477 MeV energy with a probability of 10.3%, which was measured using a NaI(Tl) crystal 3 in. in diameter. The proton beam intensity was calculated by counting ^{24}Na and ^{23}Na products in 0.050 mm thick aluminum foils for all energies except 30 MeV where the ^{12}C(p,pn)^{11}C reaction was used. The cross sections of the ^{9}Be(p,p2n)^{7}Be reaction at different energies are shown. It is concluded that the reaction ^{9}Be(p,p2n)^{7}Be could be used for monitoring proton beams. (UK)

8152 CORRELATIONS IN THE GROUND STATE OF ^{16}O AND MUON NUCLEAR ABSORPTION. Laverne, A. (Institut des Sciences Nucleaires, Grenoble, France); Goulard, B.; Do Dang, G. Can. J. Phys.; 49: 2282-4(1 Sep 1971) (In French).

The influence of 2 particle–2 hole (2p-2h) configurations of the ^{16}O ground state on the excitation probabilities of odd states in ^{16}N by muon absorption was studied. (auth) (Canada)

8153 SEARCH FOR THE BOUND TRINEUTRON FROM ^{7}Li + n REACTIONS. Koral, Kenneth F.; Silverstein, E. A.; Bevington, P. R. (Case Western Reserve Univ., Cleveland). Nucl. Phys.; A175: No. 1, 156-66(1971).

A search was made for bound trineutrons produced by bombardment of a lithium target with 19 MeV neutrons. Direct detection of the trineutrons at forward reaction angles was attempted with a helium-recoil scintillator. Trineutrons could be partially separated from a background of neutrons by correlating the time of flight between target and detector with the pulse height produced by the recoiling ^{4}He ion. No evidence for the existence of a trineutron was found over a binding-energy range of ≈0 to 7 MeV. The upper limits for the differential and total cross sections are 0.1 mb/sr and 1 mb respectively for the reaction ^{7}Li(n,^{3}n)^{5}Li and 0.8 mb/sr · MeV and 10 mb respectively for the reaction ^{7}Li(n,p)^{7}He, ^{7}He → ^{3}n + ^{4}He. (auth)

8154 STUDY OF THE REACTION ^{7}Li(d,γ)^{9}Be AT $E_d = 361$ keV. Schaeffer, M.; Suffert, M.; Magnac-Valette, D. (Laboratoire des Basses Energies, Strasbourg). Nucl. Phys.; A175: No. 1, 217-24(1971). (In French).

The reaction ^{7}Li(d,γ)^{9}Be has been studied at the $E_d = 361$ keV resonance corresponding to the second $T = {}^{3}/_{2}$ level of ^{9}Be at 16.97 MeV. The analysis of the γ-ray spectrum by an overall fitting program gives the branching ratios to the ^{9}Be levels at 1.75 MeV (11.8%), 2.43 MeV (3.3%), 2.78 MeV (13.3%) and 4.64 MeV (12.9%). These values indicate $J^{\pi} = {}^{1}/_{2}{}^{-}$ for the 16.97 MeV $T = {}^{3}/_{2}$ level and $J^{\pi} = {}^{3}/_{2}{}^{+}$ for the 4.64 MeV level. (auth)

8155 STABILITY OF α-CLUSTER STRUCTURES IN ^{8}Be AND ^{12}C NUCLEI. Abe, Yasuhisa; Hiura, Jun; Tanaka, Hajime (Hokkaido Univ., Sapporo). Progr. Theor. Phys. (Kyoto); 46: No. 1, 352-4(Jul 1971).

The molecular orbital model is used to investigate the effect of polarization of α-clusters in ^{8}Be and ^{12}C. Binding energies and density distributions are calculated and compared with cluster-model calculations. It is concluded that the dumbell cluster for ^{8}Be and the equilateral triangle cluster for ^{12}C are the most stable against polarization. (J.W.R.)

8156 ANGULAR CORRELATION STUDIES OF ELECTROMAGNETIC TRANSITIONS FOLLOWING THE ^{16}O(τ,α)^{15}O REACTION. Avida, R.; Goldberg, M. B.; Horowitz, Y.; Speidel, K.-H.; Wolfson, Y. (Weizmann Inst. of Science, Rehovot, Israel). Nucl. Phys.; A172: No. 1, 113-26(1971).

A particle-gamma angular correlation coincidence technique enabling the measurement of 0° coincidences was used to study levels in ^{15}O at 5.24 MeV ($J^{\pi} = {}^{5}/_{2}{}^{+}$), 6.18 MeV ($J^{\pi} = {}^{3}/_{2}{}^{-}$), 6.79 MeV ($J^{\pi} = {}^{3}/_{2}{}^{+}$) and 6.86 MeV ($J^{\pi} = {}^{5}/_{2}{}^{+}$). The multipole mixing ratios of the de-excitation γ-rays were determined as the following: x (5.24 → 0) = +0.08 ± 0.08 an E3/M2 mixture; x(6.86 → 5.24) = +0.04 ± 0.03, and E2/M1 mixture; x(6.79 → 0) = −0.02 ± 0.02, an M2/E1 mixture and x(6.18 → 0) = −0.121 ± 0.008 an E2/M1 mixture. The latter value is to be compared with x(E2/M1) = +0.13 ± 0.02 for the mirror 6.323 MeV transition in ^{15}N indicating $|x(^{15}\mathrm{O})| \leq |x(^{15}\mathrm{N})|$ contrary to previous findings (10). The results obtained, together with those corresponding to mirror transitions in ^{15}N are compared with recent IPM and core polarization theoretical investigations. (auth)

8157 SMALL-ANGLE TENSOR ANALYZING POWER OF (d,p) REACTIONS AND DEUTERON D-STATE EFFECTS. Brown, R. C.; Debenham, A. A.; Greenlees, G. W.; (and others) (Univ. of Birmingham, Eng.). Phys. Rev. Lett.; 27: No. 21, 1446-8 (22 Nov 1971).

The tensor analyzing power of (d,p) transitions on ^{9}Be, ^{12}C, ^{16}O, ^{19}F, ^{25}Mg, ^{28}Si, and ^{40}Ca was measured at $E_d = 12.3$ MeV for $\theta_{lab} = 0$ to 50°. The reactions studied included orbital angular-momentum transfers l = 0, 1, 2, 3. Large values of T_{20} were observed, negative near 0° for most transitions. Distorted-wave calculations show agreement with the data only when a D-state contribution is included in the deuteron internal wave function. (auth)

8158 INSTANTANEOUS CHARGES OF RECOILS FROM NUCLEAR SCATTERING. Wolke, R. L.; Sorbo, R. A.; Volkar, M. A.; Gangadharan, S.; Mason, E. V. Jr. (Univ. of Pittsburgh). Contract AT(30-1)-2771. Phys. Rev. Lett.; 27: No. 21, 1449-51 (22 Nov 1971).

The distribution of ionic charges was measured for ^{12}C recoils from the elastic scattering of 10-MeV deuterons in carbon targets down to a thickness of 0.3 μg/cm^{2}. The charge distribution from the thinner targets is distinctly nonequilibrium: this result indicates that "instantaneous" effects of the atomic and nuclear processes that produced the recoils are being observed, unmodified by electron-exchanging interactions with matter. (auth)

8159 NEW HIGH-SPIN STATES IN ^{19}F AND A POSSIBLE $K = 3^{+}/2$ BAND. Dixon, W. R. (National Research Council of Canada, Ottawa); Storey, R. S.; Aitken, J. H.; Litherland, A. E.; Rogers, D. W. O. Phys. Rev. Lett.; 27: No. 21, 1460-3(22 Nov 1971).

New levels in ^{19}F with spins of ${}^{9}/_{2}{}^{+}$ and ${}^{11}/_{2}$ were discovered at energies of 6592 ± 2 and 7937 ± 3 keV, respectively. It is suggested that these levels, together with the known 3907-keV (${}^{3}/_{2}{}^{+}$), 4549-keV (${}^{5}/_{2}{}^{+}$), and 5464-keV (${}^{7}/_{2}{}^{+}$) levels, form a $K = {}^{3}/_{2}{}^{+}$ rotational band. (auth)

8160 INELASTIC SCATTERING OF 50 MeV PROTONS BY ^{6}Li, ^{7}Li, AND ^{9}Be. Mani, G. S.; Jacques, D.; Dix, A. D. B. (Univ. of Manchester, Eng.). Nucl. Phys.; A172: No. 1, 166-84 (1971).

Differential cross sections for the inelastic scattering of 50 MeV protons by ^{6}Li, ^{7}Li and ^{9}Be were obtained. Also asymmetry measurements for the inelastic scattering by these nuclei were made for an incident proton energy of 50 MeV. The inelastic angular distributions were analyzed using the microscopic DWBA model. The interaction is constructed from an effective two-body interaction and the parameters for the effective interaction were obtained from the experimental data. The data was also analyzed in terms of first-order collective form factors. The deformations obtained were abnormally large, indicating the failure of the model. (auth)

8161 CALCULATION OF NEGATIVE PARITY STATES IN ^{17}O. Mueller-Arnke, A. (Technische Hochschule, Darmstadt, Ger.). Z. Phys.; 247: No. 5, 408-20(1971).

A shell-model calculation employing nonspurious $1\hbar\omega$ and $3\hbar\omega$ excitations is presented. The results suggest that the lowest negative-parity states are of 2p−1h type, whereas the second ${}^{1}/_{2}{}^{-}$ and higher ${}^{3}/_{2}{}^{-}$ states have dominant 4p−3h components. (auth)

8162 RESONANCE STRUCTURE IN REACTION ^{9}Be(d,γ)^{11}B. Battleson, K.; McDaniels, D. K. (Univ. of Oregon, Eugene). Phys. Rev., C; 4: No. 5, 1601-10(Nov 1971).

The reaction ^{9}Be(d,γ)^{11}B was studied over the deuteron energy range of 0.56 to 3.56 MeV. A pulsed deuteron beam and time-of-flight electronics were utilized to separate deuteron-capture γ rays from events due to neutrons and cosmic rays. From a graphical analysis of the excitation functions for the ground, first, and combined second and third excited states, two resonances are identified corresponding to ^{11}B excitation energies of 17.44 ± 0.05 and 18.37 ± 0.05 MeV. The first of these occurs at the same energy as a level in ^{11}B found from other reactions. An interpretation in terms of $1s_{1/2}$ hole states is suggested. The overall behavior of the three excitation functions is used to justify a direct-capture reaction mechanism. Angular distributions were measured at 21 different deuteron energies. The near symmetry of the angular distributions about 90° and the peaking at 90° imply that a one-step deuteron-capture process is important for this reaction if the direct-capture mechanism is dominant. An appreciable forward peaking is observed for the first-excited-state angular distribution. (auth)

8163 NEW STATES IN ^{9}Li FROM THE REACTION ^{7}Li(t,p)^{9}Li. Young, P. G.; Stokes, Richard H. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 4: No. 5, 1597-1601(Nov 1971).

Proton spectra from the reaction ^{7}Li(t,p)^{9}Li were measured at triton energies of 15 and 19 MeV. Evidence is observed for new states in ^{9}Li at excitation energies of 4.31 ± 0.03, 5.38 ± 0.06, and 6.41 ± 0.02 MeV, having widths of 0.25 ± 0.03, 0.6 ± 0.1, and <0.1 MeV, respectively. Angular distributions were obtained at $E_t = 15$ MeV for the ground, 4.31-, and 6.41-MeV states. The shape of the ground-state distribution is similar to an L = 0 distorted-wave Born-approximation calculation, in agreement with the assignment $J^{\pi} = {}^{3}/_{2}{}^{-}$ for the ground state of ^{9}Li. The relative magnitude of the cross section to the first excited state, when considered with other work, provides support for the assignment of $J^{\pi} = {}^{1}/_{2}{}^{-}$. (auth)

8164 EFFECT OF THE 7.12-MeV LEVEL IN ^{16}O ON THE α SPECTRUM FROM ^{16}N β DECAY. Werntz, Carl (Catholic Univ. of America, Washington, D. C.). Phys. Rev., C; 4: No. 5, 1591-7(Nov 1971).

Taking into account the final-state density of the leptons, a single-resonance model for the ^{12}C + α 1^{-} scattering amplitude predicts a markedly asymmetric peak in the α spectrum following ^{16}N β decay into continuum states of ^{16}O. The observed peak is nearly symmetric, and it is shown that this symmetry can arise from destructive interference from the subthreshold 1^{-} state (7.12 MeV) and/or a background from states of ~17 MeV excitation in ^{16}O. It is shown that the α width of the 7.12-MeV state must be an order of magnitude smaller than that of the 1^{-} state (9.58 MeV). (auth)

8165 SURVEY OF THE ^{8}Be GHOST ANOMALY. Berkowitz, E. H.; Marolt, G. L.; Rollefson, A. A.; Browne, C. P. (Univ. of Notre Dame, Ind.). Phys. Rev., C; 4: No. 5, 1564-70(Nov 1971).

The angular variation of the ghost anomaly is found to be identical to that of the ^{8}Be ground state for the reaction ^{9}Be(d,t)^{8}Be at $E_d = 2.5$ MeV. The anomaly is absent from deuteron spectra of the reaction ^{6}Li(α,d)^{8}Be, but present in spectra from the reactions ^{7}Li(α,t)^{8}Be and ^{9}Be(p,d)^{8}Be. End points of possible three-particle reactions lie close to the observed anomaly; thus, the interpretation is doubtful. (auth)

8166 NUCLEAR DEEXCITATION γ RAYS IN ^{14}N, ^{14}C, AND ^{15}N FOLLOWING π^- CAPTURE ON ^{16}O. Kossler, W. J. (Coll. of William and Mary, Williamsburg, Va.); Funsten, H. O.; MacDonald, B. A.; Lankford, W. F. Phys. Rev., C; 4: No. 5, 1551-9 (Nov 1971).

Negative pions produced by the National Aeronautics and Space Administration Space Radiation Effects Laboratory cyclotron were stopped in water; and the nuclear deexcitation γ rays, observed. Gamma rays from ^{14}N, ^{15}N, and ^{14}C were identified; and yields to particular states in these nuclei, obtained. A prominent γ-ray peak in the spectra was from the 3.945-MeV 1^+ state in ^{14}N, which was formed with a rate of 1.8% per stopped pion. The Doppler-broadened line shape of the decay γ ray for this state was analyzed to obtain the momentum distribution of the recoiling ^{14}N nucleus. This momentum distribution is compared with momentum distributions obtained by related experiments and to theoretical predictions. Yields to various states are presented and discussed. (auth)

8167 ELECTROEXCITATION OF THE GIANT RESONANCE OF ^{13}C. Bergstrom, J. C. (Catholic Univ. of America, Washington, D. C.); Crannell, Hall; Kline, F. J.; (and others). Phys. Rev., C; 4: No. 5, 1514-32(Nov 1971).

The giant resonance of ^{13}C was investigated by means of inelastic electron scattering. The incident energies and scattering angles employed were 77.0 MeV (75°), 106.0 MeV (75°), 55.4 MeV (145.7°) and 81.0 MeV (145.7°). The data show a distinct splitting of the resonance into two large peaks near 20.5 and 24.5 MeV. Some fine structure is observed which correlates well with the position of excitations calculated by Easlea [Phys. Lett., 1: 163(1962)]. Considerable strength, which may correspond to the "pygmy" resonance seen in the photonuclear work of Cook [Phys. Rev., 106: 300(1957)], is observed in the region of 14 MeV excitation. Data were also taken consecutively on ^{12}C. The form factors for ^{12}C and ^{13}C are compared. The presence of the extra neutron in ^{13}C results in a major restructuring of the giant-resonance strength. The possibility of an isotopic splitting in the ^{13}C giant resonance is discussed. (auth)

8168 $\pi^{\pm}$ ABSORPTION AND THE DISTRIBUTION OF NEUTRONS IN NUCLEI. Sternheim, Morton M. (Univ. of Massachusetts, Amherst); Auerbach, Elliot H. Phys. Rev., C; 4: No. 5, 1805-9(Nov 1971).

Optical-model calculations were made of the sensitivity of the ratio of $\pi^{\pm}$ absorption cross sections to the neutron-density distribution. Ratios accurate to a few tenths of 1% should be useful in determining neutron-density parameters. (auth)

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Refer also to abstracts 7163, 7767, 8149, 8157, 8168, 8224, 8228, 8229, 8300, 8317, 8336, and 8356.

8169 (AE-430) OPTICAL MODEL ANALYSES OF EXPERIMENTAL FAST NEUTRON ELASTIC SCATTERING DATA. Holmqvist, B.; Wiedling, T. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Sep 1971. 238p. Dep. NTIS (U. S. Sales Only).

Neutron elastic scattering data have been collected for a number of elements at several neutron energies. These data have been used in an attempt to get generalized analytical expressions for some parameters of the spherical optical model potential, viz. the real and imaginary potential depths and the radii of these potentials. Thus the present work gives a possibility to estimate cross sections for elements where experimental information is lacking. (auth) (Sweden)

8170 (FRNC-TH-37) PAIR AND ANTI-COMPTON SPECTROSCOPY OF THE ^{61}Ni AND ^{63}Ni ISOTOPES OBTAINED FROM THE ^{60}Ni(n,γ)^{61}Ni AND ^{62}Ni(n,γ)^{63}Ni REACTIONS. Gardien, Jean-Jacques (Paris Univ., Orsay (France). Faculte des Sciences). 1970. 37p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Low-energy ($E < 2.5$ MeV) and average-energy gamma transitions (2.5 MeV $< E <$ 8 MeV) in ^{63}Ni were studied. Fourteen new transitions were established. The level scheme is given. The energy required to separate the last neutron from ^{63}Ni calculated from the different $\gamma-\gamma$ cascades has an average value of 6838.5 ± 2.5 keV. The spins and parities attributed to the first five levels, including the ground state, are $1/2^-$, $5/2^-$, $3/2^-$, $3/1^-$, and $1/2^-$. A $3/2^-$ spin parity can be attributed to the 1324.1-keV level because of its de-excitation towards the 155.5-keV ($3/2^-$), 86.9-keV ($5/2^-$) and 0-keV ($1/2^-$) levels. The energies and intensities of the high-energy gamma lines ($E > 2.2$ MeV) are given for ^{61}Ni. Thirty new transitions were identified. The results are in good agreement with those of Groshev, Bystrov and Treado. Nevertheless, the 7.18-MeV, 5.55-MeV and 6.05-MeV lines were not observed. The results obtained for low-energy transitions ($E < 2.2$ MeV) are compared with those obtained by Bolotin, Beraud, Schoenberg and Wapetra for the β^+ disintegration of ^{61}Cu. The overall agreement is excellent. The level scheme is given. The probable cascades are indicated; these satisfy the Ritz principle and lead to levels which have already been identified in (d,p), (d,t) and (d,α) reactions. (France)

8171 (FRNC-TH-76) STUDY OF THE LEVELS OF THE ^{32}S AND ^{38}Ar NUCLEI FORMED BY THE RADIATIVE-CAPTURE REACTIONS ^{28}Si(α,γ)^{32}S AND ^{34}S(α,γ)^{38}Ar. Chevallier, Arlette (Strasbourg Univ. (France). Faculte des Sciences). 1969. 207p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Two sets of excited levels were established for ^{32}S and ^{38}Ar between 10.79 and 12.05 MeV, and 10.58 and 11.44 MeV, respectively. Most of them have a total angular momentum of 1^- or 2^+. The electromagnetic transitions, the branching ratios and the partial widths were determined using Ge(Li) detectors; the mean lifetime of the 4.29-MeV level of ^{32}S was measured using the Doppler effect. In ^{32}S all the levels observed have an isospin $T = 0$, with a normal $T = 1$ contribution, and forbidden E1 transitions are readily observed. The hindrance of E2 transitions is a function of the energy of the initial level. In ^{38}Ar, E1 transitions are no longer forbidden and mask the hindered transitions (E2), which are no longer observed. At low energies, these nuclei are considered to be formed of a ^{28}Si inert core and of $A - 28$ outer nucleons in the s and d shells. (France)

8172 (FRNC-TH-83) STUDY OF THE ^{58}Ni DECAY SCHEME. MEASUREMENT OF THE ENERGY LEVELS OF SOME Ni AND Ca ISOTOPES USING A Ge(Li) DETECTOR. Ronsin, Helene (Paris Univ. (France). Faculte des Sciences). [nd]. 77p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The level schemes of ^{40}Ca, ^{42}Ca, ^{48}Ca and ^{58}Ni were constructed to within 5 keV, by using a Ge(Li) detector. The $p'-\gamma$ coincidences for the ^{58}Ni(p,p$'\gamma$)^{58}Ni reaction were studied using first a Si junction, then a NaI(Tl) crystal and a Ge(Li) junction. Theories currently available do not give a satisfactory explanation of the ^{58}Ni nucleus. (France)

8173 (NYO-4032-62) EXPERIMENTAL B(E2)($0_2^+ \rightarrow 2_1^+$) AND PAIRING VIBRATION CALCULATIONS IN ^{40}Ar. Henson, S. H.; Cochavi, S.; Fossan, D. B.; Vergados, J. D. (State Univ. of New York, Stony Brook). 1971. 26p. Dep. NTIS.

The lifetime of the 2.12-MeV 0_2^+ state in ^{40}Ar was measured by a $p-\gamma$ delayed coincidence technique. This state was populated by the (p,p$'$) reaction with 5.3-MeV protons bombarding an Ar gas target. A mean lifetime of $\tau = 150 \pm 20$ psec was obtained for the 0_2^+ state from the slope of the decay curve. This lifetime implies for the $0_2^+ \rightarrow 2_1^+$ transition a $B(E2) = 42.9 \pm 5.7 e^2F^4$. Pairing-vibration model calculations for ^{40}Ar were made using experimental information regarding energies and B(E2) strengths for the 3 lowest levels of both ^{42}Ca and ^{38}Ar. Three kinds of interaction were considered: first, no interaction; second, a phenomenological quadrupole–quadrupole interaction; and third, the Kuo–Brown bare G-matrix elements. None of these calculations can accurately describe both the energy spectrum and the E2 transition strengths in ^{40}Ar. This result may be an indication of the inadequacy of the pairing-vibration model for ^{40}Ar. (auth)

8174 EXCITATION FUNCTIONS AT 174 DEG IN THE ELASTIC SCATTERING OF 18 TO 22 MeV α PARTICLES BY ^{23}Na, $^{24-25-26}$Mg, ^{27}Al, ^{28}Si AND ^{40}Ca. Lega, J.; Macq, P. C. (Louvain Univ., Belg.). J. Phys. (Paris); 32: Nos. 5-6, 369-72(May 1971). (In French).

The elastic scattering cross sections presented to 18 to 22 MeV α particles by ^{23}Na, $^{24-25-26}$Mg, ^{27}Al, ^{28}Si and ^{40}Ca were measured at 174° (laboratory system). They are smaller for nuclei with a neutron excess than for nuclei with 4n nucleons where they reached 10 times the Rutherford cross section for several incident energies. (France)

8175 ^{41}Ca DECAY SCHEME. Fortier, S.; Laurent, H.; Shapira, J. P. (Paris Univ., Orsay, France). J. Phys. (Paris); 32: No. 4, 231-5(Apr 1971). (In French).

A two dimensional analysis of the ^{40}Ca(d,pγ)^{41}Ca reaction was made to study the level scheme of ^{41}Ca, up to 6 MeV. The results obtained are in agreement with previous ones. The presence of 10 levels was confirmed. The γ decay scheme of 12 other levels was established. (France)

8176 SEARCH FOR A SECOND ROTATION BAND IN ^{28}Si. Gonidec, J. P.; Miehe, Christiane; Walter, Guy (CNRS, Strasbourg). Compt. Rend., Ser. B; 272: No. 24, 1385-8(14 Jun 1971). (In French).

The $^{27}Al(p,\gamma)^{28}Si$ reaction was used to measure the lifetimes and branching ratios of several ^{28}Si levels which may belong to the second rotation band predicted by Hartree–Fock calculations. (France)

8177 DECAY OF ^{79}Sr. Bilge, A. N.; Boswell, G. G. J. (Univ. of Salford, Eng.). J. Inorg. Nucl. Chem.; 33: No. 8, 2251-4(Aug 1971).

A new isotope of strontium was produced by $^{64}Zn(^{16}O,n)^{79}Sr$ reaction. The half-life of ^{79}Sr was accurately determined by milking the rubidium daughter as rubidium perchlorate. The half-life of ^{79}Sr was found to be 8.1 ∓ 0.3 m. Gamma radiation of energies of 115.7, 166.4, 188.9, 255.7, 444.2, 559.9 and 611.2 keV are associated with this decay. (auth)

8178 MEAN LIFETIME AND MAGNETIC MOMENT OF THE 2.95-MeV (6^+) STATE OF ^{54}Fe. Hensler, R. (Rutgers–The State Univ., New Brunswick, N. J.); Tape, J. W.; Benczer-Koller, N.; MacDonald, Jack R. Phys. Rev. Lett.; 27: No. 23, 1587-90(6 Dec 1971).

The mean lifetime and g factor of the 2.95-MeV 6^+ state of ^{54}Fe were measured to be $\tau = 1.76 \pm 0.03$ nsec and $|g| = 1.37 \pm 0.03$, respectively. These results are in agreement with the shell-model assignment $(f_{7/2}^{-2})_\pi$ plus a small amount of configuration mixing, which accounts for the quenching of the magnetic moment from the Schmidt limit and the enhanced E2 rate $B(E2;\ 6^+ \rightarrow 4^+) = 3.2$ Weisskopf units. (auth)

8179 ELECTROMAGNETIC DECAYS OF THE LOWEST T = 2 STATE IN ^{32}P. Adelberger, E. G. (Princeton Univ., N. J.); Balamuth, D. P. Phys. Rev. Lett.; 27: No. 23, 1597-1600(6 Dec 1971).

The γ decays of the lowest T = 2 state of ^{32}P were studied by using the reaction $^{30}Si(^3He,p\gamma)$. By combining these results with (n,γ) data, the excitation energy of the T = 2 state is found to be 5.0729 ± 0.0015 MeV. The implications of the results are discussed with reference to the search for T = 2 states in proton-rich nuclei, the comparison of analogous Gamow–Teller and M1 decays, and the search for an isotensor component of the electromagnetic field. (auth)

8180 ANALYZING POWER, POLARIZATION, AND SPIN FLIP IN INELASTIC SCATTERING AT ISOBARIC ANALOG RESONANCES. Boyd, R.; Davis, S.; Glashausser, C.; Haynes, C. F. (Rutgers–The State Univ., New Brunswick, N. J.). Phys. Rev. Lett.; 27: No. 23, 1590-3(6 Dec 1971).

Measurement of the spin-flip probability with a polarized proton beam leads to a straightforward determination of both polarization (P) and analyzing power (A) in inelastic scattering at analog resonances. Calculations including direct-reaction background indicate that P – A is insensitive to precise values of background parameters but quite sensitive to the configuration assumed for the analog state. (auth)

8181 4 GeV ELECTRON SPALLATION REACTIONS OF COBALT, IODINE, AND TANTALUM. Butement, F. D. S.; Karim, H. M. A.; Myint U, U.; Zaman, M. B. (Univ. of Liverpool). J. Inorg. Nucl. Chem.; 33: No. 9, 2791-8(Sep 1971).

Cobalt, iodine and tantalum targets were bombarded with 4 GeV electrons and the yields of $(e,e'xnyp)$, $(e,e'$ fission$)$ and $(e,e'\pi^-xn)$ reactions were measured by activation analysis and radiochemical methods. The measured cross sections were corrected for bremsstrahlung contribution. (auth)

8182 STUDY OF SOME EXCITED STATES OF ^{41}Ar BY THE $^{40}Ar(d,p\gamma)^{41}Ar$ REACTION. Meynadier, C.; Dauchy, A.; Drain, D. (Institut d'Etudes Nucleaires, Algiers). J. Phys. (Paris); 32: No. 4, 225-30(Apr 1971). (In French).

Measurements of the (p,γ) angular correlations from the $^{40}Ar(d,p\gamma)^{41}Ar$ reactions were made at $E_d = 2.8$ MeV for the following levels of ^{41}Ar: $E_{ex} = 2.398$; 2.734 and 2.947 MeV. The values of the corresponding branching ratios were improved and the previous value $J^\pi = 3/2^-$ for the 2.734 MeV level was confirmed. (France)

8183 STUDY OF THE γ CAPTURE REACTION OF PROTONS BY ALUMINUM BETWEEN $E_p = 1950$ AND 2150 keV. Dalmas, Jean; Bertault, Dominique; Irigaray, J. L.; Lapierre, Alain (Bordeaux Univ., Gradignan). Compt. Rend., Ser. B; 272: No. 23, 1326-9(7 Jun 1971). (In French).

Six (p,γ) resonances were observed for $E_p = 1967$, 1975, 1983, 2044, 2047 and 2100 keV with the respective strengths of 8, 0.1, 0.5, 50 and 5 eV for the first five reactions. The resonances at $E_p = 2054$, 2124 and 2129 keV occur in the $(p,p'\gamma)$ and $(p,\alpha_1\gamma)$ channels and do not apparently de-excite through the (p,γ) de-excitation channel. The energies of the excitation levels of the ^{28}Si nucleus were measured: $E = 8942.8 \pm 2.2$ and 10418.6 ± 2.6 keV. (France)

8184 LEVEL STRUCTURE OF ^{75}Se. Sahai, Baldev; Lal, B. (Tata Inst. of Fundamental Research, Bombay). pp 1-7 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

8185 LOW LYING LEVELS OF ^{51}Cr AND ^{59}Ni. Lal, B.; Sahai, Baldev (Tata Inst. of Fundamental Research, Bombay). pp 9-14 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

8186 NEW ISOMERIC CROSS SECTION RATIOS IN NEUTRON CAPTURE REACTIONS. Lakshmana Rao, A.; Parthasaradhi, K.; Rama Rao, J. (Andhra Univ., Waltair, India). pp 19-23 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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8187 P-WAVE NEUTRON CAPTURE IN HEAVY NUCLEI AT 25 keV. Sriramachandra Murty, M.; Siddappa, K.; Rama Rao, J. (Andhra Univ., Waltair, India). pp 29-32 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

8188 DOORWAY STATE OBSERVED AS A RESONANCE IN THE $^{35}Cl(p,p_0)^{35}Cl$ REACTION. Gupta, S. K.; Kerekatte, S. S.; Swami, S.; Dwarakanath, M. R.; Sekharan, K. K.; Divatia, A. S. (Bhabha Atomic Research Centre, Bombay). pp 39-43 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

8189 STUDY OF THE $^{64}Ni(p,n)^{64}Cu$ REACTION. Kerekatte, S. S.; Gupta, S. K.; Divatia, A. S. (Bhabha Atomic Research Centre, Bombay). pp 45-8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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8190 EVIDENCE FOR DOORWAY STATES IN $^{29}Si(\alpha,n)^{32}S$ REACTION. Balakrishnan, M.; Mehta, M. K.; Divatia, A. S. (Bhabha Atomic Research Centre, Bombay). pp 49-54 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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8191 ISOBARIC ANALOGUE STATES IN ^{67}Ga. Betigeri, M. G.; Lamba, C. M.; Sood, D. K.; Sarma, N.; Thampi, N. S. (Bhabha Atomic Research Centre, Bombay). pp 55-6 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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8192 STUDY OF THE $^{37}Cl(p,\gamma)^{38}Ar$ REACTION FOR $E_p =$ 1.5 TO 4 MeV. Puttaswamy, N. G. (Bangalore Univ., India. Argonne National Lab., Ill.); Segel, R. E. pp 153-9 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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8193 COULOMB EXCITATION OF SELENIUM ISOTOPES. Agnihotry, A. P.; Gopinathan, K. P.; Joshi, M. C.; Prasad, K. G. (Tata Inst. of Fundamental Research, Bombay). pp 161-5 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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8195 CORE-EXCITATION EFFECTS IN HARTREE–FOCK CALCULATIONS. Kulkarni, D. R.; Khadkikar, S. B.; Pandya, S. P. (Physical Research Lab., Ahmedabad, India). pp 251-4 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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8196 TWO-PARTICLE TWO-HOLE EXCITATIONS AND INTRINSIC SHAPES OF DEFORMED NUCLEI. Gunye, M. R. (Tata Inst. of Fundamental Research, Bombay); Warke, C. S.; Khadkikar, S. B. pp 307-11 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219–(Vol.2).

8199 DECAY OF ^{81m}Se (57 MIN) AND ^{81g}Se (18 MIN). Venkata Ratnam, S. (Andhra Univ., Waltair, India); Lakshminarayana, V.; Narasimham, K. L.; Ramanaiah, M. V. pp 383-6 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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8200 ANGULAR CORRELATION STUDIES IN ^{59}Co. Ramana Rao, K. Venkata; Sastry, D. L.; Lakshminarayana, V. (Andhra Univ., Waltair, India). pp 387-92 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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8201 INELASTIC SCATTERING OF 40 MeV PROTONS BY ^{58}Ni AND ^{60}Ni. Lingappa, N.; Greenlees, G. W. (Univ. of Minnesota, Minneapolis). pp 393-400 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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8202 DECAY OF ^{85m}Sr. Narasimham, K. L. (Andhra Univ., Waltair, India); Sitaramanath, M. N.; Lakshminarayana, V.; Patro, A. P. pp 441-5 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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8203 INTERNAL BREMSSTRAHLUNG FROM ^{32}P. Powar, M. S.; Singh, M. (Punjabi Univ., Patiala, India). pp 469-73 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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8204 MEASUREMENT OF (n,γ) CROSS SECTION BY ACTIVATION TECHNIQUE IN THE keV REGION. Chaturvedi, S. N.; Prasad, Rajendra (Banaras Hindu Univ., India). pp 615-18 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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8205 ELASTIC AND INELASTIC SCATTERING CROSS-SECTIONS OF CHROMIUM, IRON, AND NICKEL. Garg, S. B.; Rastogi, B. P. (Bhabha Atomic Research Centre, Bombay). pp 629-34 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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8206 INTERNAL BREMSSTRAHLUNG SPECTRUM FROM ^{32}P. Nath, M.; Mitra, S.; De, A. K.; Das, A. K.; Bhattacharya, P. C. (Calcutta Univ.). pp 673-9 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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8207 EVIDENCE FOR A $K^{\pi} = 5^+$ GROUND-STATE ROTATIONAL BAND IN ^{26}Al. Sharpey–Schafer, J. F.; Bailey, D. C.; Carr, P. E.; (and others) (Univ. of Liverpool). Phys. Rev. Lett.; 27: No. 21, 1463-5(22 Nov 1971).

Measurement of γ-ray distributions from the reaction ^{23}Na (α,nγ)^{26}Al confirms spin J = 5 for the 3404-keV level and gives an unambiguous spin assignment of J = 6 for the 3508-keV level. Measurement of lifetimes and mixing ratios shows that both states have positive parity. The excitation energy and the enhanced E2 strength of >11 Weisskopf units for the 6^+ to 5^+ ground-state transition identify the level at 3508 keV as the 6^+ member of a $K = 5^+$ rotational band based on the ground state. (auth)

8208 DOORWAY-STATE EFFECTS IN THE M1 RADIATIVE EXCITATION OF p-WAVE RESONANCES IN ^{57}Fe. Jackson, H. E.; Strait, E. N. (Argonne National Lab., Ill.). Phys. Rev. Lett; 27: No. 24, 1654-7(13 Dec 1971).

The reaction ^{57}Fe(γ,n) was studied near threshold. Intermediate structure observed in a strong p-wave resonance structure excited by M1 transitions is interpreted in terms of a doorway state resulting from a particle–hole excitation of ^{57}Fe. (auth)

8209 DECAY OF ^{87}Y. Jaspan, S.; Ramaswamy, M. K. (Fordham Univ., Bronx, N. Y.). Nuovo Cim.; 6A: No. 2, 158-62(21 Nov 1971).

The decay of 80 h ^{87}Y produced by proton bombardment of natural strontium has been investigated by means of a Ge(Li) detector in singles and in coincidence with a NaI detector. Gamma-rays of energy 388 and 487 keV with relative intensities of 95 and 100, respectively, have been observed. Coincidence data suggest levels in ^{87}Sr at 388 and 875 keV. The log ft values for transition to these levels are, respectively, 7.1 ± 0.3 and 5.2 ± 0.3. The 1.22 MeV level seen in nuclear-reaction studies is not populated in the decay of ^{87}Y (log ft > 9.8). The half-life of the isomeric level of ^{87}Sr at 388 keV has been accurately determined to be (169.8 ± 0.6) min. (auth)

8210 STRUCTURE INFORMATION ON ^{26}Mg FROM THE ^{26}Mg(p,d)^{25}Mg REACTION AT 20 MeV. Kroon, J. (Univ. of Ottawa); Fournier, R.; Hodgson, R. J. W.; (and others). Nucl. Phys.; A172: No. 1, 99-112(1971).

The angular distributions of ^{26}Mg(p,d)^{25}Mg deuteron groups to the levels in ^{25}Mg up to 3.903 MeV, which were resolved with 30 keV resolution, were compared with DWBA pick-up theory. Several levels, particularly those which are weakly populated do not fit well. A spectroscopic factor analysis was made where ^{25}Mg was assumed to consist of a deformed core with the odd neutron in a mixture of all possible N = 2 Nilsson states. The band-head spectroscopic factors then gave the filling of Nilsson states in ^{26}Mg, as $V_9 = 0.57$, $V_{11} = 0.30$ and $V_5 = 0.78$. Good agreement with the spectroscopic factors for the other N = 2 particle states in ^{25}Mg was found. However the $\frac{7}{2}^+$ and $\frac{9}{2}^+$ levels appear much more strongly than would be predicted by direct neutron pick-up theory. (auth)

8211 STUDY OF THE EXCITED STATES OF ^{23}Na FROM THE ^{22}Ne(p,γ)^{23}Na REACTION. Piiparinen, M.; Anttila, A.; Viitasalo, M. (Univ. of Helsinki). Z. Phys.; 247: No. 5, 400-7(1971).

The gamma decays of 19 resonances in the range of E_p = 400 to 1300 keV were investigated in the ^{22}Ne(p,γ)^{23}Na reaction by means of a 38-cm^3 Ge(Li) detector. Branching ratios of the resonances and bound states were determined. Gamma-ray energy measurements yield the energies of 19 bound states and the value of 8794.0 ± 1.5 keV for Q. The existence of the 3913-keV doublet state was studied through the (p,γ) reaction. No evidence for such a doublet was found. (auth)

8212 STUDY OF THE REACTIONS ^{31}P(α,p)^{34}S AND ^{29}Si(α,n)^{32}S. McMurray, W. R. (Southern Universities Nuclear Inst., Faure, S. Afr.); Holz, D. M.; van Heerden, I. J.; Wiechers, G. Z. Phys.; 247: No. 5, 453-65(1971).

The (α,p) reaction on ^{31}P in the energy range E_α = 3.25 to 5.25 MeV and the (α,n) reaction on ^{29}Si in the energy range E_α = 3 to 4.8 MeV were used to determine nuclear properties of ^{35}Cl and ^{33}S, respectively. Resonance energies, strengths, and partial widths are reported. The analysis of angular distribution measurements yields spin values for 23 resonance levels in ^{35}Cl and 14 levels in ^{33}S. (auth)

8213 NUCLEAR LARMOR PRECESSION OF THE 14 keV STATE OF ^{57}Fe IN alpha-IRON FOLLOWING THE REACTION ^{56}Fe(d,p)^{57}Fe. Riegel, D.; Weyer, G. (Freie Univ., Berlin. Hahn-Meitner Institut fuer Kernforschung, Berlin). Z. Phys.; 248: No. 2, 162-6(1971).

The spin precession of the 14-keV state of ^{57}Fe, excited by the ^{56}Fe(d,p) reaction, was observed in ferromagnetic Fe. The data yield a magnetic field of −330 ± 4 kG and a relaxation time $\tau_R >$ 500 nsec at room temperature (auth)

8214 LEVELS OF ^{29}Si WITH EXCITATION ENERGY BELOW 6.4 MeV. Bardin, T. T.; Becker, J. A.; Fisher, T. R.; Jones, A. D. W. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). Phys. Rev., C; 4: No. 5, 1625-48(Nov 1971).

Levels in ^{29}Si were populated with the reaction ^{26}Mg(α,n)^{29}Si, and subsequent γ radiation from the various levels was detected with a 37-cm^3 Ge(Li) γ-ray spectrometer. Beginning with the 4.08-MeV level, γ-ray angular distributions ($0° \le \theta_\gamma \le 90°$) were measured at incident bombarding energies near threshold ($Q_0 = 0.033$ MeV) for levels with excitation energies between 4.08 and 6.38 MeV. The target was a ^{26}Mg metal foil, on the order of 0.5 mg/cm^2 thickness. Branching ratios and excitation energies of the various levels were deduced from γ-ray pulse-height distributions. Gamma-ray angular correlations obtained at α bombarding energies near threshold were treated as originating from residual nuclei having magnetic quantum numbers $|m| = {}^1\!/_2$ and $^3\!/_2$. Analysis of these angular correlations in terms of level spin and γ-ray multipole mixing was then undertaken. Mean lifetimes (or limits) for these levels were determined using a variant of the Doppler-shift-attenuation method, which involves measurements of the attenuation for two targets of different stopping power. Both ^{26}Mg foils and ^{26}Mg–Au alloy foils (10 at. % ^{26}Mg and 90 at. % Au) were used. From these measurements, excitation energies (in keV), level spins, and lifetimes (in fsec) for these levels were deduced; these are, respectively, 4079.5 ± 0.4, $^7\!/_2$, 48 ± 8; 4740.5 ± 0.4, $^5\!/_2$ or $^9\!/_2$, 45 ± 10; 4838.5 ± 0.8, $^1\!/_2$ or $^3\!/_2$, <5; 4894.9 ± 0.6, $^5\!/_2$, 10 ± 3; 4932.6 ± 0.4, $^3\!/_2$, <10; 5254.1 ± 0.5, $^9\!/_2$, 100 ± 20; 5284.4 ± 0.7, $^3\!/_2$ or $^7\!/_2$, <10; 5651.8 ± 0.7, $^5\!/_2$ or $^9\!/_2$, 40 ± 15; 5810.7 ± 1.2, $^7\!/_2$, <20; 5946.3 ± 3.0, $^3\!/_2$, <30; 6106.6 ± 0.6, $^3\!/_2$ or $^5\!/_2$, <8; 6190.7 ± 1.3, $^3\!/_2$, $^5\!/_2$, or $^7\!/_2$, <15; and 6378.8 ± 3.0, $^1\!/_2$ or $^3\!/_2$. Excitation energies and lifetimes of levels with $E_x < 4.08$ were determined as well. These are (keV, fsec) 1273.1 ± 0.2, 360 ± 70; 2027.6 ± 0.2, 360 ± 70; 2425.0 ± 0.4, 13 ± 3; 3066.9 ± 0.5, 20 ± 7; and 3623.1 ± 0.3, 4000 ± 800. These data may be combined with the results of other investigations to arrive at a fairly complete level scheme for ^{29}Si in the energy interval $0 < E_x$ (MeV) < 6.38, including a description of the electromagnetic decay properties. These properties are compared with model predictions of the properties of ^{29}Si. (auth)

8215 NUCLEON PICKUP REACTIONS ON ^{46}Ca. Yntema, J. L. (Argonne National Lab., Ill.). Phys. Rev., C; 4: No. 5, 1621-4(Nov 1971).

The ^{46}Ca(d,t)^{45}Ca and ^{46}Ca(d,^{3}He)^{45}K reactions were investigated at an incident deuteron energy of 22.4 MeV. The angular distributions are compared with distorted-wave calculations, and the spectroscopic strength is extracted. The transitions to the $^3\!/_2^-$ levels of ^{45}Ca at 1.435 and 2.82 MeV were observed with a total strength $C^2S = 0.3$. The spectroscopic factor of the ground-state transition for the ^{46}Ca(d,^{3}He)^{45}K reaction was found to be $C^2S = 1.5 \pm 0.3$. This suggests the probability of measurable core-excitation admixtures in the ground-state configuration of ^{45}K. (auth)

8216 COUPLING OF PARTICLE-HOLE AND SURFACE EXCITATIONS IN CLOSED-SHELL NUCLEI. Castel, B. (Queen's Univ., Kingston, Ont.); Stewart, K. W. C.; Harvey, M. Phys. Rev., C; 4: No. 5, 1966-8(Nov 1971).

A simple model calculation is presented where particle–hole and surface excitations are coupled. An application to the case of ^{32}S is presented in detail. (auth)

8217 MASSES AND HALF-LIVES OF ^{20}Na, ^{24}Al, ^{28}P, ^{32}Cl, AND ^{36}K FROM THE (p,n) REACTION. Goosman, D. R.; Jones, K. W.; Warburton, E. K.; Alburger, D. E. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 4: No. 5, 1800-4(Nov 1971).

The (p,n) thresholds for the formation of ^{20}Na, ^{28}P, ^{32}Cl, and ^{36}K from targets of ^{20}Ne, ^{28}Si, ^{32}S, and ^{36}Ar, respectively, were measured relative to the ^{24}Mg(p,n)^{24}Al threshold by detecting β rays from these short-lived activities. Half-lives were determined by multiscaling techniques. The resulting (p,n) thresholds (in keV), half-lives (in msec) are as follows: ^{20}Na (15419 ± 6, 442 ± 5); ^{28}P (15666 ± 6, 266 ± 4); ^{32}Cl (13902 ± 9 and 13978 ± 16, 281 ± 8); ^{36}K (13976 ± 8, 336 ± 4). The half-life of ^{24}Al was measured as 2.054 ± 0.009 sec. (auth)

8218 ^{68}Zn(d,^{6}Li)^{64}Ni REACTION AT 27.2 MeV. Ceballos, A. E.; Erramuspe, H. J.; Ferrero, A. M. J.; Sametband, M. J.; Testoni, J. E. (Comision Nacional de Energia Atomica, Beunos Aires). Phys. Rev., C; 4: No. 5, 1959-60(Nov 1971).

The differential cross section for the reaction ^{68}Zn(d,^{6}Li)^{64}Ni at 27.2 MeV leading to the lowest 0^+ and 2^+ states was measured. The angular distributions show a diffraction pattern and forward peaking characteristic of a direct process. A distorted-wave Born approximation (DWBA) calculation in the zero-range approximation, with states represented by radial wave functions with N = 5 and N = 4 nodes for L = 0 and L = 2, respectively, was performed. The form factors correspond to the wave function of an α particle moving in a Woods–Saxon potential. From the optical-model analysis the relative strength of the 0^+ and 2^+ states can be determined within 20% error. In addition, a DWBA calculation including structure factors obtained on the basis of the pairing-plus-quadrupole model, with a coherent sum over the center-of-mass radial quantum number N, was used. The predicted ratio $\sigma(2^+)/\sigma(0^+)$ is 0.8 of the experimental value, with no significant difference in the shape of the angular distributions in both analyses. (auth)

8219 STUDY OF THE (d,p) REACTION ON ^{28}Si, ^{32}S, AND ^{36}Ar AT $E_d = 18.00$ MeV. Mermaz, M. C.; Whitten, C. A.; Champlin, J. W.; Howard, A. J.; Bromley, D. A. (Yale Univ., New Haven). Phys. Rev., C; 4: No. 5, 1778-1800(Nov 1971).

The reactions ^{28}Si(d,p)^{29}Si, ^{32}S(d,p)^{33}S, and ^{36}Ar(d,p)^{37}Ar were studied at an incident deuteron energy of 18.00 MeV. Some ^{28}Si(d,p)^{29}Si data were also obtained at an incident deuteron energy of 21.00 MeV. Angular distributions were obtained for proton groups leading to states in the residual nuclei, ^{29}Si, ^{33}S, and ^{37}Ar, with excitation energies up to approximately 8 MeV. With the use of distorted-wave Born-approximation (DWBA) analyses, spectroscopic factors were obtained for all (d,p) transitions that displayed direct-reaction characteristics. J dependence was observed in l = 2 (1d) and l = 1 (2p) (d,p) transitions for $E_d = 18.00$ MeV. The spectroscopic factors obtained in this experimental study are compared with the predictions of current theoretical models that treat nuclei in the upper s–d shell. (auth)

8220 STRUCTURE OF NUCLEI WITH MASSES A = 30 TO 35, AS CALCULATED IN THE SHELL MODEL. Wildenthal, B. H. (Michigan State Univ., East Lansing); McGrory, J. B.; Halbert, E. C.; Graber, H. D. Phys. Rev., C; 4: No. 5, 1708-58(Nov 1971).

Properties of positive-parity states of nuclei with A = 30 to 35 were calculated in a shell-model space that encompasses all Pauli-allowed basis vectors of all configurations $(0s)^4(0p)^{12}(0d_{5/2})^{n_1}(1s_{1/2})^{n_2}(0d_{3/2})^{n_3}$ for which $n_1 \ge 10$. Two different empirical Hamiltonians, one of a δ-function form, were used. Calculated energies and spectroscopic factors are in good agreement with an extensive body of experimental data. The model wave functions also yield satisfactory agreement with many available experimental data on electric quadrupole observables if effective charges of 0.5e are added to the proton and neutron. The model predictions for magnetic dipole observables are generally in qualitative agreement with experimental observations, but inconsistencies between theory and experiment are more noticeable in this area. (auth)

8221 ENERGY DEPENDENCE OF THE REORIENTATION EFFECT AND THE STATIC QUADRUPOLE MOMENT OF THE 0.847-MeV 2^+ STATE IN ^{56}Fe. Thomson, J. A.; Scharenberg, R. P.; Lutz, W. R. (Purdue Univ., Lafayette, Ind.). Phys. Rev., C; 4: No. 5, 1699-1707(Nov 1971).

The energy dependence of the reorientation effect was investigated using ^{16}O and ^{32}S ions incident on ^{56}Fe nuclei. The influence of nuclear interference on the reorientation effect was observed before it could be detected on the elastic cross section, and exhibited an angular dependence similar to that expected for the reorientation effect. It was found that an appropriate separation of projectile and target nuclei was given by $2a = R_0(A_1^{1/3} + A_2^{1/3}) + \Delta$, where $R_0 = 1.6$ fm and $\Delta \ge 3.5$ fm. The static quadrupole moment of the 0.847-MeV 2^+ state in ^{56}Fe was measured to be $Q_{22} = -0.23 \pm 0.03$ b, while the rotational value is given by $|Q_R| = 0.276$ b. (auth)

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Refer also to abstracts 6829, 6893, 6896, 6948, 7511, 7518, 7752, 7767, 8168, 8169, 8181, 8186, 8187, 8204, 8317, 8331, 8332, 8335, and 8356.

8222 (CEA-R-4201) CONTRIBUTION OF THE CURIE LABORATORY TO NUCLEAR SCIENCE. Haissinsky, Moise (Paris Univ. (France). Laboratoire Curie). Aug 1971. 95p. (In French). Dep. NTIS (U. S. Sales Only).

On the occasion of the 75th anniversary after the discovery of radioactivity the history of the Curie laboratory is recalled. The heroic period in the research made by P. and M. Curie and their collaborators in the years 1897–1914 in the extremely difficult conditions which resulted in the creation of this laboratory is briefly summarized. A description is given of the essential work carried out in the years 1918–1928, which provided much knowledge about fundamental nuclear physics, radiochemistry, and radiobiological problems. The years 1928 to 1939 were characterized by great discoveries which can be attributed entirely (fine structure of α rays, artificial radioactivity) or partially (neutron, positron, and fission) to researches in the Curie laboratories. A brief survey is given on the most important contributions made to nuclear science in the years after the war. An attempt has been made to outline the scientific and cultural contributions made by scientists who are no longer living to the greatness of the laboratory. (France)

8223 (CEC-70-1) TOTAL NEUTRON CROSS SECTION FOR ^{232}Th IN THE ENERGY REGION 1.5 TO 8.5 MeV. Fasoli, U.; Toniolo, D.; Zago, G.; Zuffi, L. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy). Centro di Calcolo). Feb 1970. 17p. Dep. NTIS (U. S. Sales Only).

The total neutron cross section for ^{232}Th was measured in the energy region 1.5 to 8.5 MeV. The experimental data analyzed in terms of a nonspherical optical potential. (auth)

8224 (CONF-701219-(Vol.2)) PROCEEDINGS OF THE NUCLEAR PHYSICS AND SOLID STATE PHYSICS SYMPOSIUM, MADURAI, DECEMBER 27-30, 1970. VOLUME II. NUCLEAR PHYSICS. (Department of Atomic Energy, Bombay (India). Physics Committee). 1970. 698p.

The papers presented are listed by title and indexed separately. (W.H.K.)

For abstracts of individual papers see: 6860–6862, 6903, 6954, 7478, 7488, 7699–7704, 7723, 7753, 7983, 8110–8117, 8132, 8144–8150, 8184–8206, 8231–8263, 8333–8354, and 8376–8378.

8225 (HEDL-TME-71-106) THEORETICAL CALCULATIONS OF FAST NEUTRON CAPTURE CROSS SECTIONS. Schmittroth, F. A. (Hanford Engineering Development Lab., Richland, Wash.). Aug 1971. Contract AT(45-1)-2170. 50p. Dep. NTIS.

Hauser–Feshbach calculations with width-fluctuation corrections for neutron capture are made for several fission-product nuclei: ^{103}Rh, ^{127}I, ^{93}Nb, ^{95,97,98}Mo. Also included is ^{197}Au, which is sometimes used as a standard. Since the purpose of these calculations is to test the accuracy of the theory, no adjustment of the input parameters is made to improve agreement between experiment and theory. For favorable cases, we find that the theory gives capture cross sections to within 10 to 20% of the experimental values. For less favorable cases, errors of 50% should be expected. (auth)

8226 (N-71-34642) FAST NEUTRON REACTIVITY EFFECTS FOR REFRACTORY METALLIC SAMPLES MEASURED IN A THERMAL HOMOGENEOUS REACTOR. Pierce, Clarence R.; Fieno, Daniel; Shook, Donald F. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Sep 1971. 26p. (NASA-TN-D-6494). NTIS.

Measurements and interpretations of fast neutron reactivity effects were made for metallic samples in a thermal uranyl fluoride–water-solution reactor. Experimental reactivity coefficients were obtained for a number of refractory metals enclosed by either a thick ^{10}B shell or a cadmium shell located at the center of the cylindrical reactor. Calculated reactivities were obtained using a one-dimensional spherical model of the reactor and the multigroup S_n method. The measurements, along with the analytical procedure described, provide an integral test of fast neutron cross sections. Measured and calculated epiboron effective absorption integrals are in agreement within the uncertainty of the measurement for tungsten, tantalum, and niobium; the calculated integral underestimated measured values for molybdenum by 35% and overestimated the measured values for rhenium by 65%. (auth) (STAR)

8227 (UCRL-20426) NUCLEAR CHEMISTRY. Annual Report, 1970. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1971. Contract W-7405-eng-48. 343p. Dep. NTIS.

Separate abstracts were prepared for ten of the eleven subject areas covered. One section is listed by title only. (J.W.R.)

For abstracts of individual sections see: 6534, 6570, 6571, 6651, 6942, 7523, 7752, 8228–8230, and 8319.

8228 (UCRL-20426, pp 1-52) NUCLEAR SPECTROSCOPY AND RADIOACTIVITY. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1971.

From Nuclear chemistry.

ACTINIUM-220— alpha decay of, $\alpha-\gamma$ and $\gamma-\gamma$ coincidence spectra from, (E)
ARGON-36— energy level from Coulomb excitation, quadrupole moment of first-excited, (E)
BERKELIUM-249— energy-level scheme from einsteinium-253 decay, (E)
ERBIUM-157— energy-level scheme for, (E)
ERBIUM-159— energy-level scheme for, (E)
NOBELIUM-259— alpha decay of, α spectra and half-life for, (E)
RADIUM-214— energy levels from (HI, xn) reactions, (E)
RADON-212— energy levels from (HI, xn) reactions, (E)
SAMARIUM-154— energy levels from Coulomb excitation, lifetimes and transition probabilities for, (E)
SILVER— proton spallation at 5.5 GeV, particle spectra from, (E)

8229 (UCRL-20426, pp 53-95) NUCLEAR REACTIONS AND SCATTERING. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1971.

From Nuclear chemistry.

ALPHA PARTICLES— scattering by tungsten-182 at 60 MeV, α spectra and deformation parameters for inelastic, (E)
ARGON-38— helium-3 reactions (He-3,t) at 40 MeV, triton spectra and angular distributions for, (E)
CARBON-9— proton decay of, proton spectra from beta-delayed, (E)
CARBON-12— oxygen-16 reactions (O-16, C-12) at 69.5 MeV, particle spectra and angular distributions for, (E)
CERIUM-140— proton reactions (p,t) at 30 MeV, triton spectra and angular distributions for, (E)
— proton inelastic scattering at 30 MeV, proton spectra from, (E)
CERIUM-142— proton reactions (p,t) at 30 MeV, triton spectra and angular distributions for, (E)
LEAD-208— alpha inelastic scattering at 65 MeV, structure in cross section for, (E)
NEON-20— proton inelastic scattering using polarized beam, coupled-channel calculation using Thomas spin-orbit potential, (E)
NEON-22— proton inelastic scattering using polarized beam, coupled-channel calculation using Thomas spin-orbit potential, (E)
OSMIUM ISOTOPES— energy levels from (α,2n) and (p,2n) reactions, systematics of even-A, (E)
OXYGEN-16— reactions (O-16, C-12) with carbon-12 at 69.5 MeV, particle spectra and angular distributions for, (E)
RHENIUM-187— proton reactions (p,2nγ) at 14 MeV, γ spectra from, (E)
TUNGSTEN-182— alpha inelastic scattering at 60 MeV, α spectra and deformation parameters for, (E)
TUNGSTEN-184— alpha reactions (α,2nγ) at 30 MeV, γ spectra from, (E) (J.W.R.)

8230 (UCRL-20426, pp 150-75) FISSION. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1971.

From Nuclear chemistry.

CALIFORNIUM-252— fission of, mass and kinetic energy of fragments from spontaneous, (E)
FISSION FRAGMENTS— mass and kinetic energy of californium-252, identification from γ spectra, (E)
— gamma transitions in odd-A, even-Z, (E)
— angular momentum distributions of, method for determination of
NUCLEI— fission probabilities of $Z < 88$, single-particle and pairing effects on, (T)
— particle-induced fission of $Z < 88$, effect of approximations in calculation of first chance probabilities for, (E) (J.W.R.)

8231 P-WAVE STRENGTH FUNCTIONS IN THE MASS REGION $140 < A < 160$. Thirumala Rao, B. B.; Rama Rao, J.; Kondaiah, E. (Andhra Univ., Waltair, India). pp 25-8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8232 FRAGMENT ANGULAR DISTRIBUTIONS IN THE 14 MeV NEUTRON INDUCED FISSION OF ^{232}Th, ^{233}U, ^{235}U, ^{238}U, ^{237}Np, ^{239}Pu, AND ^{241}Am USING SOLID-STATE TRACK DETECTORS. Iyer, R. H.; Sagu, M. L. (Bhabha Atomic Research Centre, Bombay). pp 57-65 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).
From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8233 EXCITATION FUNCTIONS FOR THE NEUTRON INDUCED FISSION OF HEAVY NUCLEI. Iyengar, K. N.; Iyer, R. H.; Kapoor, S. S.; Nadkarni, D. M.; Sagu, M. L. (Bhabha Atomic Research Centre, Bombay). pp 67-71 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).
From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8234 EMISSION OF LONG RANGE CHARGED PARTICLES IN THE FISSION OF ^{235}U BY THERMAL TO 4 MeV NEUTRONS. Nadkarni, D. M.; Kapoor, S. S. (Bhabha Atomic Research Centre, Bombay). pp 73-8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).
From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8235 KINETIC ENERGY DISTRIBUTION IN THE REACTOR NEUTRON INDUCED FISSION OF ^{241}Am. Prakash, Satya; Manohar, S. B.; Dange, S. P.; Ramaswami, A.; Ramaniah, M. V. (Bhabha Atomic Research Centre, Bombay). pp 79-83 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).
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8236 K^- ABSORPTION IN ^{157}Gd. Chattarji, D. (Visva-Bharati Univ., West Bengal, India). pp 121-4 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).
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8237 NUCLEAR ENERGY LEVEL CALCULATIONS OF THE BARIUM ISOTOPES IN THE UNIFIED MODEL. Chandran, C. R.; Sitaramanath, M. N.; Ramanamurty, M. V.; Ramamurty, S. (Andhra Univ., Waltair, India). pp 193-6 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).
From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8238 EFFECT OF PAIRING ON PARTICLE-CORE COUPLING CALCULATIONS. Chalapati Rao, K. V. (Saha Inst. of Nuclear Physics, Calcutta). pp 197-200 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).
From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8239 INTERNAL CONVERSION COEFFICIENT MEASUREMENTS IN ^{133}Ba DECAY. Narasimha Rao, C.; Mallikarjuna Rao, B.; Ramanaiah, K. Venkata; Reddy, K. Venkata (Andhra Univ., Waltair, India). pp 327-30 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).
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8240 HIGH RESOLUTION SPECTROSCOPY OF ^{164}Ho. Pathak, B. P. (Saha Inst. of Nuclear Physics, Calcutta); Mukherjee, S. K.; Gujrathi, S. C. pp 331-5 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).
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8241 DELAYED GAMMA-RAY EMISSION IN THE SPONTANEOUS FISSION OF ^{252}Cf. Ajitanand, N. N. (Bhabha Atomic Research Centre, Bombay). pp 339-43 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).
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8242 L/K CAPTURE RATIO FROM Ge(Li) SPECTRUM. Dasmahapatra, B. K. (Saha Inst. of Nuclear Physics, Calcutta). pp 345-8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).
From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8243 FURTHER STUDIES OF K X-RAY EMISSION FROM ^{252}Cf FRAGMENTS. Kapoor, S. S.; Nadkarni, D. M.; Murthy, S. R. S.; Ramamurthy, V. S.; Rama Rao, P. N. (Bhabha Atomic Research Centre, Bombay). pp 349-59 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).
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8244 DECAY OF ^{126}I. Murty, K. S. N.; Pathak, B. P.; Chatterjee, M. L. (Saha Inst. of Nuclear Physics, Calcutta). pp 361-3 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).
From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8245 HALF-LIFE OF 687.42 keV LEVEL AND ENERGY LEVELS IN ^{147}Pm. Singh, H.; Sethi, B. (Saha Inst. of Nuclear Physics, Calcutta). pp 371-5 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).
From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8246 GAMMA-GAMMA DIRECTIONAL CORRELATIONS OF THE 552-134 keV CASCADE IN ^{187}Re. Narasimha Raju, M. L.; Khayyoom, A.; Sastry, D. L. (Andhra Univ., Waltair, India). pp 403-5 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).
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8247 GAMMA-GAMMA ANGULAR CORRELATIONS IN ^{95}Mo(n,γ)^{96}Mo REACTION. Chintalapudi, S. N.; Sastry, D. L.; Jnanananda, Swami (Andhra Univ., Waltair, India). pp 407-10 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).
From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8248 HALF-LIFE OF 126 keV STATE IN ^{107}Ag. Jain, H. C. (Tata Inst. of Fundamental Research, Bombay); Bhattacherjee, S. K.; Baba, C. V. K. pp 411-14 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).
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8249 g-FACTOR OF THE 603-keV LEVEL IN ^{124}Te BY BETA-GAMMA PERTURBED ANGULAR CORRELATIONS. Agnihotry, A. P.; Joshi, M. C.; Prasad, K. G. (Tata Inst. of Fundamental Research, Bombay). pp 415-19 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).
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8251 DECAY OF $^{115\,m}$Cd AND THE EXCITED LEVELS OF ^{115}In. Chaturvedi, S. N. (Banaras Hindu Univ., India); Rangacharyuly, C.; Mehta, G. K.; Nath, N. pp 427-33 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).
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8253 BETA-GAMMA DIRECTIONAL CORRELATION MEASUREMENTS IN THE DECAY OF ^{142}Pr. Khayyoom, A.; Narasimha Raju, M. L.; Sastry, D. L. (Andhra Univ., Waltair, India). pp 447-50 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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8255 DECAY OF ^{148}Eu. Lakshminarayana, V. (Andhra Univ., Waltair, India); Hamilton, J. H.; Brahmvar, S.; Dunn, D. pp 453-8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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8256 TRIPLE GAMMA COINCIDENCE AND ANGULAR CORRELATION STUDIES IN ^{110}Cd FROM THE DECAY OF ^{110m}Ag. Pande, U. S.; Singh, B. P. (Univ. of Roorkee, India). pp 459-62 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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8257 GAMMA-GAMMA-GAMMA DIRECTIONAL ANGULAR CORRELATION STUDIES IN ^{160}Dy FROM THE DECAY OF ^{160}Tb. Pande, U. S.; Singh, B. P. (Univ. of Roorkee, India). pp 463-8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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8258 NUCLEAR MATRIX ELEMENTS OF ^{122}Sb BETA DECAY. Palathingal, J. C. (Univ. of Cincinnati). pp 477-81 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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8259 DECAY OF ^{131}I. Suri, K. K.; Trehan, P. N. (Panjab Univ., Chandigarh, India). pp 489-93 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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8260 DECAY OF ^{160}Tb TO LEVELS IN ^{160}Dy. Suri, K. K.; Trehan, P. N. (Panjab Univ., Chandigarh, India). pp 495-8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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8261 DECAY OF ^{107}In. Chatterjee, M. B.; Baliga, B. B. (Saha Inst. of Nuclear Physics, Calcutta). pp 499-502 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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8262 METHOD OF MEASUREMENT OF ABSOLUTE DISINTEGRATION RATE OF A RADIO-ACTIVE SOURCE. Joneja, O. P.; Coachman, J. S.; Navalkar, M. P. (Bhabha Atomic Research Centre, Bombay). pp 561-5 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

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8263 STATUS OF ^{239}Pu CAPTURE TO FISSION CROSS-SECTION RATIO MEASUREMENTS. Rastogi, B. P.; Kapil, S. K. (Bhabha Atomic Research Centre, Bombay). pp 635-8 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8264 ^{223}Ra LEVEL SCHEME. III. THE STUDY OF $\gamma\gamma$ COINCIDENCES AND MEAN LIVES. Briancon, C.; Walen, R. (CNRS, Orsay, France). J. Phys. (Paris); 32: Nos. 5-6, 381-95 (May 1971). (In French).

A description of the multidimensional (1 024 × 1 024 channels) study of $\gamma\gamma$ coincidences in ^{223}Ra is given. After numerical treatment of the data the existence, classifications and intensities of about 50 transitions were established. Mean lives, greater than 30 to 80 ps, were determined using a method based on the emission of γ rays by atoms in flight after α-recoil. A substantial number of the transition probabilities were obtained. (France)

8265 MECHANISM OF NUCLEAR REACTIONS INDUCED BY HIGH ENERGY ALPHA PARTICLES. Bimbot, R.; Le Beyec, Y. (Paris Univ., Orsay). J. Phys. (Paris); 32: No. 4, 243-58 (Apr 1971). (In French).

^{4}He induced reactions on heavy nuclei were studied. The experimental excitation functions for the following reactions: ^{208}Pb(α,xn), x = 6 to 12; ^{206}Pb(α,pxn), x = 3 and 4; ^{208}Pb(α,pxn), x = 5 and 6, between 60 and 150 MeV are given. The results obtained show the important role played by noncompound mechanisms in these reactions. They were compared with the results of Griffin precompound model. Agreement between experiments and theory is not observed beyond 80 MeV. The possible reasons for this divergence are discussed. A second way of interpreting noncompound processes consists in the possibility of (α,nucleon) knock-out. While a single collision between a peripheral nucleon and the incident alpha particle cannot account for the observed (α, xn) cross section, the possibility of multiple collisions might explain the experimental results. (France)

8266 DECAY PROPERTIES OF ^{114}Ag. Rosner, G.; Herrmann, G. (Univ., Mainz). J. Inorg. Nucl. Chem.; 33: No. 8, 2684-7(Aug 1971).

The 5 second activity of ^{114}Ag was confirmed by bombarding ^{114}Cd metal enriched to 96.7% with 14 MeV neutrons from the T-D reaction. No evidence for a 2 min activity ^{114}Ag was found. Fermi-Curie plots of β-ray spectra of ^{114}Ag obtained with a plastic scintillator are given and the γ-ray spectrum taken 7 sec after 10 irradiations of 20 one-g samples of natural Cd metal are shown to support the conclusions. (UK)

8267 INTERACTIONS OF HIGH-ENERGY PROTONS WITH TANTALUM NUCLEI. I. CHARGE DISPERSION AND MASS DISTRIBUTION. Trabitzsch, U.; Baechmann, K. (Technische Hochschule, Darmstadt, Ger.). Radiochim. Acta; 16: No. 1, 15-24(Aug 1971). (In German).

The cross sections of some rubidium, strontium, yttrium and zirconium isotopes for the interaction with tantalum with 580 MeV and 19 GeV protons were determined. The charge dispersion curve for the products of the isobar A = 86 was plotted for both proton energies. The shape of both curves corresponds almost to a Gaussian distribution. The N/Z_p ratio and the halfwidth of the curves are 1.263 and 1.85 Z-units, respectively, (580 MeV proton energy) and 1.216 and 1.93 Z-units, respectively (19 GeV proton energy). The isobaric yield is 5.5 mb at 19 GeV proton energy; thus it is roughly ten times higher than that for 580 MeV proton energy. N/Z_p values of charge dispersion curves for various targets and energies of bombardment were summarized and represented as a function of the A_I/A_T value (mass of isobar/mass of target). It turned out that both at low energies of bombardment (<1 GeV) and at higher energies of bombardment (>1 GeV) there is a direct relationship between the N/Z_p values and the A_I/A_T values for each target nucleus. The mass distribution curves for $50 < A < 170$ were plotted for both proton energies. (auth)

8268 ANALYSIS OF DELAYED-NEUTRON YIELDS FROM ^{252}Cf. Chulick, E. T. (Washington Univ., St. Louis); Reeder, P. L.; Bemis, C. E.; Eichler, E. Radiochim. Acta; 16: No. 1, 8-11(Aug 1971).

A calculation of delayed-neutron abundances from individual precursors for spontaneous fission of ^{252}Cf accounts for 65 ± 18% of the total delayed-neutron yield. (auth)

8269 DELAYED NEUTRON YIELDS OF THE LONGER-LIVED HALOGEN PRECURSORS IN THERMAL NEUTRON FISSION OF ^{235}U. del Marmol, P.; Fettweis, P.; Perricos, D. C. (CEN/SCK, Mol, Belg.). Radiochim. Acta; 16: No. 1, 4-7 (Aug 1971).

The ^{137}I/^{87}Br and ^{88}Br/^{87}Br delayed neutron ratios were measured respectively as 4.85 ± 0.20 and 1.7 ± 0.2 after chemical separation from thermal neutron fission of ^{235}U. Delayed neutron yields are proposed for ^{87}Br, ^{88}Br and ^{137}I and the half lives of ^{87}Br and ^{137}I are remeasured with higher precision. By comparing the neutron activities of ^{87}Br and ^{137}I to the γ-activities of their daughters ^{87}Kr and ^{137}Xe, their P_n values are evaluated. (auth)

8270 MASS DISTRIBUTION AND THE TOTAL FISSION CROSS SECTION IN THE FISSION OF ^{238}U WITH PROTONS OF ENERGIES RANGING BETWEEN 13 AND 55 MeV. Baba, S.; Umezawa, H.; Baba, H. (Japan Atomic Energy Research Inst., Tokai). Nucl. Phys.; A175: No. 1, 177-98(1971).

The fission of ^{238}U with protons of energy ranging from 13 to 55 MeV was studied radiochemically. The mass-yield curve was obtained for each of the eleven incident energies, and an analysis was performed, based on the two-mode-fission mechanism. The observed total chain yields were reasonably reproduced by the combination of the three Gaussian curves with partial distortions. The deduced number of neutrons emitted in the fission was found to agree well with the postulated value in the study of the charge distribution systematics. For the three highest incident energies, the formation of the fissile nuclei through a direct process was shown to occur and the analyzing method was discussed. The peak-to-trough ratio and the total fission cross section were obtained from thus-established mass distribution curves. (auth)

8271 MICROWAVE METHOD FOR LIFETIME MEASUREMENTS OF NUCLEAR STATES EXCITED BY alpha-PARTICLE DECAY. Korolev, G. A.; Vorobyov, A. A.; Zalite, Yu. K. (Ioffe Physical-Technical Inst., Leningrad). Nucl. Instrum. Methods; 97: No. 2, 323-9(1971).

A method is described for measuring short lifetimes of converted γ-transitions fed by α-particle decay. A combination of a β-spectrometer and a microwave cavity is used for timing conversion electrons. The α-particles are timed with another hf cavity which modulates the energy of secondary electrons produced by the α-particles in a foil and accelerated up to 2 keV. The time resolution of the arrangement is about 50 ps. Methods of data analysis are discussed and the results of lifetime measurements of excited states in ^{219}Rn and ^{207}Tl are given. (auth)

8272 A NEW VERSION OF THE MICROWAVE METHOD. Dar, Y. (Faculty of Physics, Technion, Haifa, Israel); Gerber, J.; Macher, A.; Vivien, J. P. Nucl. Instrum. Methods; 97: No. 2, 251-62(1971).

Description and analysis are presented for a new version of the microwave method for measuring short lifetimes of excited nuclear states. (auth)

8273 MEASUREMENTS ON THE g-FACTOR OF SHORT-LIVED EXCITED NUCLEAR STATES WITH THE APPLICATION OF A SUM-TECHNIQUE. Dorum, O.; Selsmark, B. (Technical Univ. of Denmark, Lyngby). Nucl. Instrum. Methods; 97: No. 2, 243-9(1971).

A method for the measurement of the positive and the negative rotation of an angular correlation simultaneously without reversing the perturbing magnetic field is presented. The technique has been applied to measure the g-factor of the 2^+(122 keV) rotational state in ^{152}Sm. The result, corrected for paramagnetic effects, is $g = 0.298 \pm 0.033$ which is in agreement with previous measurements. (auth)

8274 GAMMA–GAMMA–GAMMA ANGULAR CORRELATION METHOD AND TRIPLE GAMMA ANGULAR CORRELATION STUDIES IN ^{133}Cs FROM THE DECAY OF ^{133}Ba. Pande, U. S.; Singh, B. P. (Univ. of Roorkee, India). Nucl. Instrum. Methods; 97: No. 1, 123-30(1971).

A $\gamma-\gamma-\gamma$ angular correlation method for radiations from radioactive nuclei is described. Three NaI(Tl) detectors are used for the detection of γ-radiations. Two geometries were used for the mounting of these three detectors. Angular correlation studies for the cascade 276 keV → 79.6 keV → 81 keV in ^{133}Cs from the decay of ^{133}Ba were made. The multipolarity of the 79.6 keV γ transition is discussed. (auth)

8275 MOESSBAUER EXPERIMENTS ON ^{180}Hf AND THE STRUCTURE OF THE 8^- TWO-QUASIPARTICLE STATE. Koerner, H. J.; Wagner, F. E.; Dunlap, B. D. (Argonne National Lab., Ill.). Phys. Rev. Lett.; 27: No. 23, 1593-6(6 Dec 1971).

The magnetic moment of the 1142-keV 8^- state of ^{180}Hf was deduced from the known hyperfine splitting of the isomeric state in $(\mathrm{Hf}_{0.1}\mathrm{Zr}_{0.9})\mathrm{Fe}_2$ and the hyperfine field in this compound. This field, $H_{hf} = -200 \pm 20$ kOe, was obtained from Moessbauer experiments with the 93.3-keV γ rays of ^{180}Hf. The deduced result, $\mu(8^-) = +(8.6 \pm 1.0)\ \mu_N$, identifies the 8^- state as a virtually pure two-proton configuration. (auth)

8276 DECAY SCHEME OF 1.3 h ^{174}Ta. Charvet, A.; Do Huu Phuoc; Duffait, R.; Emsallem A.; Chery, R. (Lyon Univ.). J. Phys. (Paris); 32: Nos. 5-6, 359-67(May 1971).

The decay of ^{174}Ta ($T_{1/2} = 1.3$ h) was studied using Ge(Li) and Si(Li) detectors. Single, coincidence and sum γ-ray spectra, conversion lines and $e-\gamma$ coincidence relations were measured. The results are in good agreement with those of earlier investigations for the ground state and the β-vibrational band. Above these bands 14 levels were established having the following energies (in keV), spin values, and parities: 276.8(3,4); 1 318.9(2^+); 1 394.4(3,4); 1 448.9(3^-); 1 503.3(4^+); 1 659.2(4^+); 2 030.1(3,4); 2 124.5(3,4); 2 145.5(4^+); 2 198.2(4^-); 2 237.3(5); 2 490.5(3,4); 2 590.7(3,4) and 3 023.7(2). The level scheme accounts for 49 of the 60 transitions firmly assigned to the decay of ^{174}Ta. The Q-value of the decay $^{174}\mathrm{Ta} \rightarrow {}^{174}\mathrm{Hf}$ was determined to be 3845 ± 80 keV. The half life of the first 2^+ level was measured and found to be 1.68 ± 0.08 ns. The structure of ^{174}Ta and the levels of ^{174}Hf are discussed in terms of current nuclear models. (France)

8277 ^{223}Ra LEVEL SCHEME. II. INTERNAL CONVERSION ELECTRON SPECTRA EMITTED IN THE $^{227}\mathrm{Th} \rightarrow {}^{223}\mathrm{Ra}$ DECAY. Briancon, C.; Vieu, C. (CNRS Orsay, France). J. Phys. (Paris); 32: Nos. 5–6, 373-80(May 1971). (In French).

All results concerning the complex conversion spectrum emitted in the $^{227}\mathrm{Th} \rightarrow {}^{223}\mathrm{Ra}$ decay are summarized. Semi-circular magnetic spectrography and absolute measurements with a double focusing spectrometer yielded absolute intensities in α disintegration units, as well as many multipolarities. (France)

8278 SOME NEW RESULTS ON NEUTRON-RICH EVEN MASS STRONTIUM NUCLEI. Macias-Marques, M. I. (Paris Univ., Orsay, France); Johnson, A.; Foucher, R.; Henck, R. J. Phys. (Paris); 32: No. 4, 237-41(Apr 1971). (In French).

The gamma spectra of neutron-rich even–mass rubidium isotopes from ^{90}Rb to ^{96}Rb were studied using a Ge(Li) detector; in the case of the $^{90}\mathrm{Rb} \rightarrow {}^{90}\mathrm{Sr}$ decay, $\gamma-\gamma$ coincidences were performed and a level scheme for ^{90}Sr is proposed. From the energies of the first 2+ levels of ^{90}Sr, ^{92}Sr, ^{94}Sr, ^{96}Sr conclusions are drawn about the deformation of these nuclei and about the position of the neutron $d_{5/2}$ sub-shell. (France)

8279 MEASUREMENTS OF AVERAGE CROSS SECTION FOR ^{232}Th(n,2n)^{231}Th REACTION TO NEUTRONS WITH FISSION-TYPE REACTOR SPECTRUM AND OF GAMMA-RAY INTENSITIES OF ^{231}Th. Kobayashi, Katsuhei; Hashimoto, Tetsuo; Kimura, Itsuro (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo); 8: No. 9, 492-7(Sep 1971).

The average cross section for the ^{232}Th(n,2n)^{231}Th reaction to neutrons with the energy spectrum close to that of fission neutrons was obtained in the core of the Kyoto University Reactor, KUR. The value obtained was 12.5 ± 0.84 mb. This value agrees satisfactorily with Phillips' and with the calculated value obtained with the cross section in the U-K library and the Maxwellian fission neutron spectrum given by Leachman. A somewhat poorer agreement is seen with the calculated value obtained from Butler & Santry's cross section and Leachman's spectrum. The discrepancy amounts to 24 and to 39% respectively, for the average cross sections calculated with these two excitation functions and the fission neutron spectrum given by McElroy. By making use of a Ge(Li) counter whose photopeak efficiency had been carefully calibrated, the absolute intensities were determined for eleven photopeaks observed on the γ-ray spectrum emitted by ^{231}Th. (auth)

8280 DECAY OF ^{167}Yb (18 min) TO ^{167}Tm. Funke, L. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.); Kaun, K. H.; Kemnitz, P.; (and others). Nucl. Phys.; A175: No. 1, 101-12(1971).

The level scheme of the deformed nucleus ^{167}Tm has been investigated in the decay of ^{167}Yb using germanium detectors and a magnetic β-spectrograph. The conversion electron spectrum, single γ-ray spectra and prompt and delayed $\gamma-\gamma$ coincidences were measured. A decay scheme is proposed involving 25 excited states in ^{167}Tm and approximately 60 of the more than 100 new transitions. In the low-energy region the first members of the rotational bands $\frac{1}{2}^+$ [411], $\frac{1}{2}^-$[541], $\frac{7}{2}^+$[404], $\frac{7}{2}^-$[523] and $\frac{3}{2}^+$[411] could be identified. Possibilities of interpretation of the high-lying levels are discussed on the basis of microscopic theory. (auth)

8281 HALF-LIFE AND ANGULAR CORRELATION MEASUREMENTS IN THE DECAY OF ^{147}Eu. Belt, R. A.; Funk, E. G.; Mihelich, J. W. (Univ. of Notre Dame, Ind.). Nucl. Phys.; A175: No. 1, 129-40(1971).

The half-lives of the 121.3 and 197.4 keV states of ^{147}Sm populated in the decay of ^{147}Eu were measured by the delayed coincidence method to be 0.77 ± 0.04 nsec and 1.26 ± 0.04 nsec respectively. An upper limit of ≤ 0.2 nsec was placed on the half-lives of the 798.8, 1054.4 and 1077.2 keV states. Partial γ-ray mean lifetimes were calculated using theoretical internal conversion coefficients and mixing ratios which were obtained from published experimental L subshell ratios. A measurement of the 76–121 keV $\gamma-\gamma$ directional correlation yielded the correlation coefficients $A_2 = -0.34 \pm 0.14$ and $A_4 = -0.15 \pm 0.14$. For a $\frac{3}{2}(D,Q)\frac{5}{2}(D,Q)\frac{7}{2}$ spin sequence, these data are consistent with quadrupole contents of 26^{+20}_{-3}% and 10 ± 4% for the 76 and 121 keV transitions respectively, in agreement with experimental L subshell ratios. The energies and relative intensities of γ-rays from an isotopically separated source of ^{147}Eu were measured using a Ge(Li) detector. Newly observed transitions of 505.2 and 749.9 keV are tentatively placed populating the state at 798.8 keV. A decay scheme is proposed, based on the measured γ-ray energies and available coincidence data. (auth)

8282 HIGH-SPIN ROTATIONAL LEVELS IN ^{159}Dy. Boutet, J. (Institut des Sciences Nucleaires, Grenoble, France); Torres, J. P. Nucl. Phys.; A175: No. 1, 167-76(1971). (In French).

The reaction ^{158}Gd(α,3n)^{159}Dy has been used to populate states in ^{159}Dy. Gamma rays have been studied by means of γ−γ coincidence. Assignments have been made for the bands built on the Nilsson states $\frac{3}{2}^{-}$[521], $\frac{11}{2}^{-}$[505]; a mixed positive parity band has been also observed. (auth)

8283 SEARCH FOR WEAK TRANSITIONS IN THE DECAY OF ^{108m}Ag. Hamilton, J. H. (Vanderbilt Univ., Nashville); Brahmavar, S. M.; Gupta, J. B.; Lide, R. W.; Stelson, P. H. Nucl. Phys.; A172: No. 1, 139-44(1971).

The decay of ^{108m}Ag ($T_{1/2}$ > 5y) has been studied with large-volume (60 cm^3) Ge(Li) detectors to search for weak transitions in this decay. The ^{108m}Ag sources were prepared from neutron capture on natural silver in the early 1950's and 1960's. In addition to the well-known 723.0, 614.4, 434.0 keV (100%) triple cascade in ^{108}Pd, only the (0.15 ± 0.01%) 633 keV transition in ^{108}Cd was observed from the decay of ^{108}Ag via the isomeric decay of ^{108m}Ag. Evidence for a very weak (0.005%) 836.5 keV transition was found. Upper limits were placed on the intensity of any other transitions in this decay. The isomeric branching is (7.7 ± 0.8)%. (auth)

8284 DECAY OF ^{238}Am. Post, J. C.; Aten, A. H. W. Jr. (Instituut voor Kernphysisch Onderzoek, Amsterdam. Univ., Amsterdam). Radiochim. Acta; 16: No. 1, 60(Aug 1971).

Among the data concerning the decay of ^{238}Am recently published [Radiochim. Acta 15, 205(1971)], the existence of the two weak gamma-lines at 1022.3 and 1066.1 keV is doubtful. Recent measurements suggest that what was observed in these cases were coincidences between the plutonium K-line at 103.6 keV and the high intensity gamma-rays at 918.7 keV and 962.7 keV. This means that the level suggested at 1066.2 keV does not exist either and should be deleted from the decay scheme. (auth)

8285 LOW-ENERGY-DEUTERON FISSION CROSS SECTIONS OF ^{231}Pa MEASURED WITH MICA TRACK DETECTOR. Nakanishi, Takashi; Sakanoue, Masanobu (Kanazawa Univ., Japan). Radiochim. Acta; 16: No. 1, 24-7(Aug 1971).

The excitation function for the deuteron induced fission of ^{231}Pa was studied with mica track detectors in the energy range of 4.0-11.2 MeV. In the same energy region, cross sections for (d,f) reactions of ^{238}U and ^{232}Th were also studied as a control experiment of track technique, and proved to be consistent with literature values measured by other techniques. Some advantages of this track technique and the experimental conditions for stack method were discussed in view of the radiation damage of track detectors in the deuteron beam. (auth)

8286 ANGULAR DISTRIBUTIONS OF FISSION FRAGMENTS IN THE FIRST CHANCE FISSION OF ^{198}Hg. Natowitz, J. B.; Chulick, E. T. (Texas A and M Univ., College Station). Nucl. Phys.; A172: No. 1, 185-92(1971).

The angular distributions of fission fragments from the fission of ^{198}Hg produced in the reaction of 16.8 MeV to 40.0 MeV protons with ^{197}Au have been measured with mica track detectors. By the method of least squares the theoretical expression for W(θ) due to Halpern and Strutinski was fit to the experimental data, with K_0^2, the variance of the K quantum number distribution, maintained as a free parameter. Even at 2.1 MeV, the lowest excitation energy above the fission barrier reached in the present work, the values of K_0^2 obtained are consistent with the availability of intrinsic states of excitation. Thus, $2\Delta_f$, the pairing energy at the saddle point, is apparently less than 2.1 MeV, indicating that any increase in the saddle-point pairing energy over the ground state pairing energy is less than ≈25% in ^{198}Hg. (auth)

8287 DECAY OF 1.9 h ^{198m}Tl AND 5.3 h ^{198g}Tl TO LEVELS IN ^{198}Hg. Pakkanen, A. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-905. Nucl. Phys.; A172: No. 1, 193-214(1971).

The decay of 1.9 h ^{198m}Tl and 5.3 h ^{198g}Tl was investigated using Ge(Li), NaI(Tl) and plastic detectors and a Ge(Li)−Ge(Li) coincidence spectrometer. In addition to known excited states at 412, 1049, 1636, 1684, 1910 and 2125 keV, the levels at 1816, 2059, 2203 and 2516 keV in ^{198}Hg are found to be populated in the decay of ^{198m}Tl. The observed delay of 6.6 ± 0.5 ns between K X-rays and γ-rays has been attributed to the E2 transition between the states at 1684 keV (6^- or 7^-) and 1636 keV (5^-). In the decay of ^{198g}Tl, 55 levels below 3.2 MeV are populated. In contrast to ^{200}Hg, no low-lying 0^+ state could be established in ^{198}Hg. However, the results of angular correlation measurements cannot exclude the 0^+ assignment for a weakly populated level at 1402 keV. Comparisons with the neighboring even Hg isotopes and some theoretical calculations have been made. (auth)

8288 ENERGY LEVELS OF ^{121}Sb AND ^{123}Sb ISOTOPES FROM THE (n,n′γ) REACTION. Barnard, E.; Coetzee, N.; De Villiers, J. A. M.; Reitmann, D.; Van der Merwe, P. (Atomic Energy Board, Pretoria). Nucl. Phys.; A172: No. 1, 215-24(1971).

The low-lying energy level structures of the stable antimony isotopes were investigated with the aid of the (n,n′γ) reactions utilizing a 40 cm^3 Ge(Li) detector, a pulsed neutron source and time-of-flight gating methods. Most of the de-excitation γ-rays observed could be associated with the energy level schemes of ^{121}Sb and ^{123}Sb. Some new levels are postulated and the results are compared with the latest model calculations. (auth)

8289 POPULATION OF THE GROUND-STATE ROTATIONAL BAND OF ^{168}Yb BY MEANS OF ^{4}He-, ^{3}He-, DEUTERON- AND PROTON-INDUCED REACTIONS. De Jesus, A. S. M.; Mills, S. J.; Rautenbach, W. L. (National Physical Research Lab., Pretoria). Nucl. Phys.; A172: No. 2, 323-36(1971).

Using five different reactions, all leading to the final nucleus ^{168}Yb, the relative intensities of the prompt γ-ray transitions in the ground state rotational band of this nucleus were measured at various energies of the incident particles. It was found that, except in the neighborhood of a reaction threshold, these relative intensities are only dependent on the angular momentum of the initial compound nucleus and not on its excitation energy. The results were compared with calculations based on the statistical description of compound nuclear reactions. A reasonably good simultaneous fit to all the experimental results was obtained for an effective moment of inertia equal to half the rigid-body moment of inertia. The importance of previously neglected corrections due to interfering reactions on the targets is discussed. (auth)

8290 FISSION FRAGMENT MASS DISTRIBUTIONS AND KINETIC ENERGIES FOR SPONTANEOUS FISSION ISOMERS. Ferguson, R. L.; Plasil, F.; Alam, G. D.; Schmitt, H. W. (Oak Ridge National Lab., Tenn.). Nucl. Phys.; A172: No. 1, 33-40 (1971).

Fission fragment energy correlation experiments have been carried out for spontaneous fission isomers formed in the following reactions: ^{240}Pu(p,2n)^{239m}Am, ^{239}Pu(d,2n)^{239m}Am, ^{237}Np(d,2n)^{237m}Pu, ^{238}U(d,pn)^{238m}U and ^{235}U(d,p)^{236m}U. The fragment mass distributions, total kinetic energies, and fragment distribution averages and widths are consistent with prompt, low-excitation fission systematics of the actinides. It is argued that fragment configurations, including mass and energy distributions, are determined in the same region of the multidimensional potential surface describing the fission process for both types of fission. Evidence which indicates that this region may begin in the neighborhood of the second barrier is discussed. (auth)

8291 LEVEL PROPERTIES OF ^{96}Mo INVESTIGATED VIA MULTIPLE COULOMB EXCITATION, Ge(Li)−Ge(Li) DIRECTIONAL CORRELATIONS AND THE DECAY OF ^{96}Nb AND ^{96mg}Tc. Barrette, J.; Barrette, M.; Boutard, A.; (and others) (Univ. of Montreal). Nucl. Phys.; A172: No. 1, 41-65(1971).

Oxygen-16 ions with energies of 35 to 44.8 MeV have been used to Coulomb excite levels of the even molybdenum isotope ^{96}Mo. The de-excitation γ-radiations from the Coulomb excited states at 778.22(2^+), 1148.0(0^+), 1497.70(2^+), 1625.8(2^+), 1628.10(4^+), 1869.51(4^+) and 2234.5 keV (3^-) have been observed with a 45 cm^3 Ge(Li) detector having 2.0 keV resolution for the ^{60}Co lines. The reduced electromagnetic transition values for most of the observed transitions were calculated using the general formulation of the semi-classical theory to first and second order. It is shown that this treatment is quite adequate to extract reliable results from the simple and double E2 Coulomb excitation process in the ^{96}Mo nucleus. In addition, Ge(Li)−Ge(Li) directional correlation measurements were performed on cascades from the decays of ^{96}Nb and ^{96g}Tc. These experiments showed that the 719.55 keV γ-ray de-exciting the $2^{+\prime}$ state at 1497.70 keV to the 2^+ level at 778.22 keV is mostly an M1 transition ($\delta = -0.42^{9}_{7}$) and that the 2440.64 and 2755.0 keV levels have, most probably, a spin-parity value of 6^+. Furthermore, a reinvestigation of the disintegration of ^{96}Nb and the ^{96m,g}Tc isomeric pair, performed with the 45 cm^3 Ge(Li) detector, revealed the existence of several new γ-transitions and levels in the structure of ^{96}Mo. (auth)

8292 POSSIBLE EXPLANATION FOR GROSS-STRUCTURE OBSERVATIONS IN THE DIRECT SCATTERING OF HELIUM IONS. Chant, N. S. (Univ. of Washington, Seattle. Univ. of Minnesota, Minneapolis); Henley, E. M. Phys. Rev. Lett; 27: No. 24, 1657-60(13 Dec 1971).

A tentative explanation of the broad plateau observed in the spectra from direct scattering of helium ions producing highly excited nuclear states is advanced. In the case of ^{4}He projectiles, it is proposed that, in addition to the suggested formation of short-lived ^{5}He (^{5}Li), the excitation of single-particle states in the continuum with and without subsequent nucleon emission can account for the data. Calculations are presented which corroborate this conjecture. (auth)

8293 ACCURATE DESCRIPTION OF THE REACTION ^{92}Mo (d,n)^{93}Tc TO UNBOUND ANALOG STATES. Fortune, H. T. (Univ. of Pennsylvania, Philadelphia); Vincent, C. M. Phys. Rev. Lett; 27: No. 24, 1664-6(13 Dec 1971).

The results of distorted-wave Born-approximation calculations for the reaction ^{92}Mo(d,n)^{93}Tc to unbound $d_{5/2}$, $s_{1/2}$, and $d_{3/2}$ analog states are presented. Unlike the results of previous authors, the calculated angular distributions agree with experiment (to within 20%) at forward angles. The distorted-wave Born approximation with single-particle form factors describes the reaction with as much accuracy as for bound final states. (auth)

8294 NEUTRON RADIUS OF ^{208}Pb FROM SUB-COULOMB PICKUP. Koerner, H. J. (Argonne National Lab., Ill.); Schiffer, J. P. Phys. Rev. Lett.; 27: No. 21, 1457-60(22 Nov 1971).

The (d,t) and (p,d) reactions on ^{208}Pb were studied at several energies below the Coulomb barrier. Relatively simple and parameter-free analysis yields the absolute normalization of the asymptotic tail for the neutron states near the Fermi surface. A wide range of Woods–Saxon potentials that match the binding energy and the asymptotic tail yield a rather unique value of the rms radius for the neutron excess, namely 5.99 ± 0.10 fm. This is very close to the radius deduced from Coulomb-energy differences. (auth)

8295 ENERGY LEVELS OF ^{174}Yb POPULATED IN THE DECAY OF ^{174}Tm. Tuurnala, T.; Pursiheimo, V.; Liukkonen, E. (Univ. of Helsinki). Z. Phys.; 247: No. 5, 436-43(1971).

The decay of ^{174}Tm activity was studied with Ge(Li) detectors and with a Ge(Li)–NaI(Tl) coincidence arrangement. Gamma-ray energies and relative intensities were determined. Five new γ transitions are reported, four of which are placed in the decay scheme, in addition to the previously observed but unplaced 1305-keV transition. Five energy levels at 1557.7, 1762.1, 1781.1, 1877.5, and 2050.1 keV not earlier reported to be populated in the decay of ^{174}Tm are suggested. Some spin and parity assignments are proposed, and the intrinsic structure of several states is discussed in terms of two quasi-particle excitations. For the half-life of ^{174}Tm a value 5.4 ± 0.1 min was measured. (auth)

8296 ELECTRON CAPTURE DECAY OF 51 MIN ^{191}Hg. Beuscher, H.; Jahn, P.; Lieder, R. M.; Mayer-Boericke, C. (Kernforschungsanlage, Juelich, Ger.). Z. Phys.; 247: No. 5, 383-99(1971).

The decay $^{191}\mathrm{Hg} \rightarrow {}^{191}\mathrm{Au}$ was investigated by measuring γ-ray spectra, conversion electron spectra, and coincidence spectra, as well as lifetimes in the second region. The parent isotope ^{191}Hg was produced by the reaction ^{197}Au(d,8n) with $E_d = 80$ MeV. About 80 γ transitions of this decay were observed. Multipolarities of the more intense transitions were determined. An isomeric state of 0.92 ± 0.11 s half-life was found in ^{191}Au. A level scheme for ^{191}Au is suggested. The measured γ transitions are attributed to the decay of a $13/2^{+}$ isomeric state of ^{191}Hg; its half-life was found to be 50.8 ± 1.5 min. The core excitation model was used to discuss some features of the level structure in ^{191}Au. (auth)

8297 GAMMA-RAY SPECTROSCOPY OF ^{185m}W. Pathak, B. P.; Gujrathi, S. C.; Mukherjee, S. K. (Saha Inst. of Nuclear Physics, Calcutta). Indian J. Phys.; 44: No. 1, 19-29(Jan 1970).

The γ decay characteristics of ^{185m}W were investigated using Ge(Li) and NaI(Tl) spectrometers. The samples of ^{185m}W were produced through ^{186}W(n,2n)^{185m}W reactions by irradiating tungsten oxide enriched in ^{186}W (97.8%) with 14.8 MeV neutrons. A half-life of 1.65 ± 0.05 min was assigned to its decay. Gamma rays with 66.2, 94.5, 107.9, 122.3, 131.8, 164.7, 174.1, and 188.3 keV energies were found decaying with 1.65 min half-life. The results of singles and coincidence measurements are incorporated into a decay scheme. The levels of 75-day ^{185}W populated by the decay of 1.65-min ^{185m}W are established at 0, 23.6, 66.2, 93.8, 174.1, and 188.3 keV. The 1.65-min isomeric state is placed at 198.0 keV. The results of the present measurements are found to be consistent with those obtained in a recent work. (auth)

8298 CROSS SECTIONS FOR THE PRODUCTION OF ^{84}Rb, ^{86}Rb, ^{132}Cs, AND ^{136}Cs FROM THORIUM AND URANIUM BY 28.5-GeV PROTONS. Franz, E. M.; Friedlander, G. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 4: No. 5, 1671-3(Nov 1971).

Absolute cross sections for the formation of ^{84}Rb, ^{86}Rb, ^{132}Cs, and ^{136}Cs in uranium and thorium interactions with 28.5-GeV protons were determined by γ-ray counting of chemically separated samples. The cross sections obtained are as follows: for thorium: ^{84}Rb, 6.55 ± 0.37 mb; ^{86}Rb, 6.75 ± 0.37 mb; ^{132}Cs, 1.30 ± 0.06 mb; ^{136}Cs, 1.13 ± 0.07 mb; for uranium: ^{84}Rb, 6.88 ± 0.33 mb; ^{86}Rb, 7.27 ± 0.34 mb; ^{132}Cs, 2.10 ± 0.10 mb; ^{136}Cs, 2.64 ± 0.15 mb. (auth)

8299 HIGH-RESOLUTION STUDY OF ^{56}Co BY (d,α) AND (^{3}He,p) REACTIONS. Schneider, M. J.; Daehnick, W. W. (Univ. of Pittsburgh). Phys. Rev., C; 4: No. 5, 1649-70(Nov 1971).

Levels of ^{56}Co up to 4.4 MeV excitation were studied by the direct ^{58}Ni(d,α)^{56}Co reaction at a deuteron energy of 17 MeV. Experimental resolution of 9 to 12 keV permitted investigation of many previously unknown states. ^{54}Fe(^{3}He,p)^{56}Co spectra at $E_{^{3}\mathrm{He}} = 18$ MeV were taken in order to supplement an earlier low-resolution study at the same energy. The total experimental resolution obtained for this reaction was 16 keV; this permitted investigation of previously unresolved doublets. Accurate (±0.3%) excitation energies were obtained for about 80 ^{56}Co levels. ^{58}Ni(d,α)^{56}Co angular distributions obtained by other investigators with 12- and 15-MeV deuterons had presented serious difficulties in the attempted analysis with distorted-wave Born-approximation (DWBA) calculations. At 17 MeV, given l values led to characteristic shapes that could be recognized empirically and crudely fit by "conventional" DWBA curves. Stock et al. [Nucl. Phys., A104: 136(1967)] have shown that finite-range corrections become less important and DWBA results more reliable for (^{3}He,α) if $V_{^{3}\mathrm{He}} + V_n \approx V_\alpha$. This prescription is generalized to two-nucleon transfers and similarly positive results are found, provided that the radii of all real wells are kept near $1.2A^{1/3}$ fm. With this "well-matching" prescription, microscopic DWBA calculations improved to the point that the correlation of $l = 0, 2, 4, 6$ curves to positive-parity states became unambiguous. In the study of individual ^{56}Co states the (p,^{3}He) and (^{3}He,t) results of other investigators supplemented these data to suggest J^{π} assignments or narrow J^{π} limits for 46 states. It was found particularly useful to investigate the $\sigma(\mathrm{d},\alpha)/\sigma(\mathrm{p}^{3}\mathrm{He})$ ratio for given l transfer. As expected on theoretical grounds, cross sections for J^{+} (odd) levels showed large and nearly constant ratios. Ratios for transition strengths to known J^{+} (even) states were significantly smaller and vanished for T> states. The properties of 15 low-lying levels could be correlated with those of states predicted in recent shell-model calculations by J. McCrory. The importance of two-particle–two-hole configurations in most of these states was demonstrated. Remaining discrepancies might be explained by a sizable four-hole–two-particle strength in ^{58}Ni (g.s.). (auth)

8300 SIGN OF Δ, THE AMPLITUDE MIXING RATIO OF γ TRANSITIONS, AND β–γ–γ AND γ–γ–γ ANGULAR-CORRELATION STUDIES. Singh, B. P.; Dahiya, H. S.; Pande, U. S. (Univ. of Roorkee, India). Phys. Rev., C; 4: No. 5, 1510-13(Nov 1971).

The method of β–γ–γ and γ–γ–γ angular correlation is used to determine the sign of δ (the amplitude mixing ratio in γ-ray transitions) independent of phase conventions. (auth)

8301 CHARACTERISTICS OF FRAGMENTS PRODUCED IN THE INTERACTION OF 5.5-GeV PROTONS WITH SILVER. Hyde, Earl K.; Butler, Gilbert W.; Poskanzer, A. M. (Univ. of California, Berkeley). Phys. Rev., C; 4: No. 5, 1759-78(Nov 1971).

The energy spectra of nuclear fragments produced by the interaction of 5.5-GeV protons with silver were determined at several laboratory angles by means of dE/dx–E measurements with semiconductor-detector telescopes. Individual isotopes of the elements from hydrogen to nitrogen were resolved. From oxygen to silicon the elements were determined without isotopic separation. For the case of the isotopes of He through Be enough of the evaporation-like energy spectra were recorded so that it was possible to perform integrations to obtain angular distributions and total cross sections. For elements above beryllium, an experimental cutoff on the low-energy side precluded these integrations, and only the high-energy portions of the spectra were recorded. The energy spectra of the neutron-deficient isotopes differ from the others in that the high-energy parts of the spectra are more pronounced and flatter, and the angular distributions are more forward-peaked. Some of the energy spectra were fitted with calculated curves based on the isotropic evaporation of fragments from an excited nucleus moving along the beam axis. The apparent Coulomb barriers obtained from this analysis were about one half the nominal Coulomb barriers, and the apparent nuclear temperatures fell in the 8- to 11-MeV range. However, no one temperature could fit the entire energy range, and for the highest-energy fragments observed at 90° the apparent temperature rose to 20 MeV or higher. From the forward–backward shifts of the most probable energy it was deduced that the average velocity of the moving system emitting Li and Be fragments is 0.008c. However, all of the data are more forward-peaked in intensity than can be explained by the simple two-step model. The energy analysis carried out on these new data is compared with those results given in the literature for silver targets or emulsions bombarded with protons, cosmic rays, pions, kaons, and other particles. Comparisons are made of the present results with those obtained in an earlier study of fragments from a uranium target. (auth) (78 references)

8302 PARITY-VIOLATING ASYMMETRY OF THE 501-keV GAMMA RAY EMITTED IN THE DECAY OF ^{180m}Hf. Krane, K. S.; Olsen, C. E.; Sites, James R.; Steyert, W. A. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C.; 4: No. 5, 1906-13(Nov 1971).

The parity-violating forward–backward asymmetry of the 501-keV γ radiation emitted by ^{180m}Hf polarized at low temperatures is measured to be $-(1.66 \pm 0.18)\%$ at a polarization of 72%. From this asymmetry the magnitude of the irregular $\tilde{\mathrm{E}}2/\mathrm{M}2$ mixing ratio is deduced to be 0.038 ± 0.004, in good agreement with results of circular polarization measurements. The regular E3/M2 multipole mixing ratio of the 501-keV γ ray is deduced to be 5.3 ± 0.3, in agreement with results of directoral-correlation measurements. The hyperfine splitting energy of ^{180m}Hf introduced as an impurity in $ZrFe_2$ is deduced to be $-(7.9 \pm 0.5)$ mK. (auth)

8303 INTERNAL-CONVERSION CASCADES IN FISSION PRODUCTS. St.-Laurent, Rodrigue; Phillips, Gary W.; Richard, Patrick; Moore, C. Fred (Univ. of Texas, Austin). Phys. Rev., C; 4: No. 5, 1948-56(Nov 1971).

A two-parameter coincident (x-ray–x-ray)measurement was made using a Si(Li) x-ray detector and a Ge(Li) x-ray detector to study the x-ray production in the ^{252}Cf fission process. K x-ray peaks from adjacent Z fission products are well resolved in both detectors. The measurement yields the result that there is a large number of coincident events with x rays from the same Z element as well as with x rays from the complementary fission product (e.g., Cs K x rays are in coincidence with both the complementary Tc K x rays and the Cs K x rays). The various possibilities one may consider are K x-ray production by the primary fission process followed by internal conversion, multiple K x-ray production in the stopping process of the fission products, K-shell ionization resulting from β decay of the fission fragments followed by internal conversion in the same fragment, and multiple internal-conversion processes from cascading transitions. Each of these four possible causes for self-coincident x-ray production is explored. (auth)

8304 PARITY MIXING AND NUCLEAR STRUCTURE IN THE DECAYS FROM ORIENTED ^{153} ^{159}Gd AND ^{161}Tb. Krane, K. S.; Olsen, C. E.; Sites, James R.; Steyert, W. A. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 4: No. 5, 1942-7(Nov 1971).

Measurement of the angular distribution of the 363-keV γ radiation following the decay of ^{159}Gd oriented in $GdFe_2$ at low temperatures yielded a vanishing value of the parity-nonconserving forward–backward asymmetry, the result indicating in this transition no large effect resulting from the parity-violating weak nucleon–nucleon interaction. Vanishing asymmetries were observed for other strongly hindered transitions in ^{159}Tb and in ^{161}Dy. The 0–90° anisotropy of the 363-keV angular distribution yielded a value for the magnetic moment of the ^{159}Gd ground state of $\mu = (-0.44 \pm 0.03)\mu_N$. The magnitude of the hyperfine field of Tb in $GdFe_2$ was estimated to be 370 ± 80 kG, based on observation of the 0–90° anisotropy of γ transitions in ^{161}Dy. The multipole characters of various β and γ transitions following the decay of oriented ^{153,159}Gd and ^{161}Tb are deduced. (auth)

8305 LOW-ENERGY TRANSITIONS FROM THE DEEXCITATION OF SPONTANEOUS FISSION FRAGMENTS OF ^{252}Cf. Hopkins, F. F.; Phillips, G. W.; White, J. R.; Moore, C. Fred; Richard, Patrick (Univ. of Texas, Austin). Phys. Rev., C; 4: No. 5, 1927-41(Nov 1971).

Low-energy γ rays, in the range from 45 to 230 keV, following the spontaneous fission of ^{252}Cf were observed with a high-resolution Ge(Li) detector [full width at half maximum (FWHM) 500 eV at 81 keV] in coincidence with K x rays from the fission fragments, observed with a Si(Li) detector (FWHM 350 eV at 31 keV). Sixteen 1024-channel γ-ray spectra were accumulated and sorted by computer; the spectra corresponded to windows set on K x rays from Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Pr, Ce, La, Ba, Cs, Xe, I, and Sb. In conjunction with previous works, these data allowed both mass and charge assignments to be made for a number of the observed γ-ray transitions. (auth)

8306 DETERMINATION OF THE CHARGE AND MASS DISTRIBUTION IN THE FISSION OF ^{252}Cf. Cheifetz, E.; Wilhelmy, J. B.; Jared, R. C.; Thompson, S. G. (Univ. of California, Berkeley). Phys. Rev., C; 4: No. 5, 1913-26 (Nov 1971).

A new technique is presented for determining mass and charge distributions in fission. This method is based on obtaining the independent yields of the even–even fission products from the measured intensities of $2^+ \rightarrow 0^+$ ground-state-band transitions deexciting the prompt-fission products. Transition intensities for members of ground-state bands in 36 even–even fission-product nuclei were used to determine the centroids (Z_p) and widths (σ_Z) of the charge distribution for eight chains of fission products with constant mass and also to determine the centroids (Z_A), widths (σ_A), and yields (Y_Z) of the mass distribution for 12 chains of fission products with constant charge. The method was applied to analyze the charge and mass distributions of ^{252}Cf spontaneous fission. The results when compared with the standard radiochemical and K x-ray technique give satisfactory agreement. The discrepancies that exist are predominantly associated with regions influenced strongly by nuclear shells. Examples are given relating the observed ground-state-band transition intensities with other observed fission variables such as kinetic energy release and neutron-evaporation systematics. (auth)

8307 PRECISION MEASUREMENT OF HALF-LIVES AND SPECIFIC ACTIVITIES OF ^{235}U AND ^{238}U. Jaffey, A. H.; Flynn, K. F.; Glendenin, L. E.; Bentley, W. C.; Essling, A. M. (Argonne National Lab., Ill.). Phys. Rev., C; 4: No. 5, 1889-1906 (Nov 1971).

New determinations of the half-lives of ^{235}U and ^{238}U were made. Improved techniques allowed the half-life values to be measured with greater accuracy than has been heretofore achieved. Samples were prepared by molecular plating and counted in an intermediate-geometry α proportional counter with an extremely flat pulse-height plateau. The small amount of residual nonplated uranium was counted in a 2π counter. Energy analysis with a silicon-junction detector was used to measure the presence of "foreign" activities. For ^{235}U, the measured specific activity was (4798.1 ± 3.3) (dis/min)/(mg ^{235}U), corresponding to a half-life of $(7.0381 \pm 0.0048) \times 10^8$ yr. For ^{238}U, the specific activity was measured as (746.19 ± 0.41) (dis/min)/(mg ^{238}U), corresponding to a half-life of $(4.4683 \pm 0.0024) \times 10^9$ yr. Errors quoted are statistical (standard error of the mean), based upon the observed scatter of the data. This scatter exceeds that expected from counting statistics alone. It is believed that systematic errors, if present, will no more than double the quoted errors. (auth)

8308 EXCITED STATES IN ^{91}Nb FROM THE ^{91}Zr(p,nγ)^{91}Nb REACTION. Matthews, Dennis L.; Lindsey, Terry P.; Koike, Masahiro; Moore, C. Fred (Univ. of Texas, Austin). Phys. Rev., C; 4: No. 5, 1876-88(Nov 1971).

In-beam γ-ray measurements of the excited states in ^{91}Nb were made using the reaction ^{91}Zr(p,nγ)^{91}Nb at incident proton energies between 3.0 and 6.3 MeV. Singles, threshold, and γ–γ coincidence measurements were made using Ge(Li) detectors and an on-line two-parameter data acquisition system. By these methods more than 70 γ rays associated with the deexcitation of levels in ^{91}Nb were observed. γ–γ coincidence spectra produced by gates on 12 of the stronger transitions were used along with a threshold experiment to identify 43 levels with energies up to 4.3 MeV excitation. Twelve of these levels, having energies of 1984, 2326, 2331, 2992, 3066, 3126, 3179, 3274, 3328, 3434, 3462, and 3636 keV, have not been previously reported. Branching ratios are given along with a decay scheme for ^{91}Nb. (auth)

8309 SPECTROSCOPY OF ^{93} ^{95} ^{97}Tc THROUGH THE (d,n) REACTION. Riley, P. J.; Horton, J. L.; Hollas, C. L.; Zaidi, S. A. A. (Univ. of Texas, Austin). Phys. Rev., C; 4: No. 5, 1864-76(Nov 1971).

The (d,n) reaction on ^{92}Mo, ^{94}Mo, and ^{96}Mo was studied at 12 MeV deuteron bombarding energy by using the neutron time-of-flight technique with an over-all neutron time resolution of 1.9 nsec. Angular distributions of neutron groups leading to states in ^{93}Tc, ^{95}Tc, and ^{97}Tc were measured in the angular range between 15 and 70°. The measured cross sections are analyzed in the framework of the distorted-wave theory of stripping reactions to deduce the l values and proton spectroscopic factors of the states in the residual nuclei. The results are compared with the corresponding data available from (^{3}He,d) studies. Arguments based on the shell-model theory are used to make tentative spin assignments. The fractionation of the single-particle states and their centroid energies are determined. Tentative

^{92}Mo, ^{94}Mo, and ^{96}Mo ground-state configurations are deduced from the analysis. (auth)

8310 COMPOUND-NUCLEUS CONTRIBUTION TO (p,p') REACTIONS. Rao, G. R.; Balasubramanian, R.; Cohen, B. L.; Fink, C. L.; Degnan, J. H. (Univ. of Pittsburgh). Phys. Rev., C; 4: No. 5, 1855-63(Nov 1971).

A clean separation is made between the compound-nucleus and direct-reaction contributions to the low-energy continuum region of the energy spectra of protons from inelastic scattering. Bombarding energies are 12 and 17 MeV, and target nuclei are the isotopes of Ni, Zr, Cd, Mo, and Sn. The compound-nucleus contribution is studied by determining level-density parameters and the proton-to-neutron-emission ratios. These are in good agreement with predictions from statistical theory. (auth)

8311 TWO NEW ALPHA-PARTICLE EMITTING ISOTOPES OF ELEMENT 105, ^{261}Ha AND ^{262}Ha. Ghiorso, Albert; Nurmia, Matti; Eskola, Kari; Eskola, Pirkko (Univ. of California, Berkeley). Phys. Rev., C; 4: No. 5, 1850-5(Nov 1971).

Two new α-emitting isotopes of element 105 with mass numbers 261 and 262 were discovered. The 8.93-MeV 1.8-sec ^{261}Ha was produced by the reactions ^{250}Cf(^{15}N,4n)^{261}Ha and ^{249}Bk(^{16}O,4n)^{261}Ha, and the 8.45-MeV 40-sec ^{262}Ha, by the reaction ^{249}Bk(^{18}O,5n)^{262}Ha. The isotopic assignments are based on both α-recoil milking and mother-daughter time-correlation measurements. An upper limit of 50% for branching by spontaneous fission was set for ^{261}Ha. A so far unassigned 25-sec spontaneous-fission activity was observed in the bombardment of ^{249}Bk with ^{18}O ions. (auth)

8312 ISOBARIC ANALOGS IN THE (e,e'p) REACTION WITH ^{138}Ba, ^{140}Ce, ^{142}Nd, AND ^{144}Sm. Shoda, K.; Saito, T.; Sugawara, M.; (and others) (Tohoku Univ., Sendai). Phys. Rev., C; 4: No. 5, 1842-9(Nov 1971).

The energy distributions of protons from the (e,e'p) reaction on N = 82 nuclei with even Z were measured. The cross sections of the $(\gamma,p_0 + p_1)$ reaction are estimated. Two prominent isobaric analogs were found in each nucleus. The results are used for the systematic discussion of the odd–odd parent nuclei ^{138}Cs, ^{140}La, ^{142}Pr, and ^{144}Pm. The 1^- states are estimated at 600 and ~2500 keV for ^{138}Cs, 500 and 3000 keV for ^{140}La, 1100 and 3700 keV for ^{142}Pr, and 1400 and 4300 keV for ^{144}Pm. The parameters of these states are discussed in terms of a quasi-proton and single-neutron model. (auth)

8313 LOW-ENERGY LEVEL STRUCTURE OF ^{198}Hg. Beraud, R. (Institut de Physique Nucleaire de Lyon, Villeurbanne, France); Berkes, I.; Haroutunian, R.; (and others). Phys. Rev., C; 4: No. 5, 1829-41(Nov 1971).

The ^{198}Hg level scheme was investigated by using ^{198}Tl and ^{198m}Tl $(\epsilon + \beta^+)$ decays. A level scheme is proposed in which the following spins and parities were determined by means of γ and conversion-electron spectra and $\gamma-\gamma$ angular correlations: 1401.4 keV, $I^\pi = 0^+$; 1612.7 keV, $I^\pi = 2^+$; 1635.6 keV, $I^\pi = 5^-$; 1832.8 keV, $I^\pi = 2^+$; 1846.8 keV, $I^\pi = 3^+$; 1858.9 keV, $I^\pi = 2^+$; 1900.7 keV, $I^\pi = 2^+$; 2360.6 keV, $I^\pi = 3^+$. The isomeric cross-section ratio $\sigma(\alpha,3n)^{m}/\sigma(\alpha,3n)^{g.s.}$ was measured to be 5 ± 1 for 35 MeV $\leq E_\alpha \leq$ 42 MeV. Lifetimes of two negative-parity states were determined: $\tau(1635.6\ \text{keV}, 5^-) = 89 \pm 15$ psec and $\tau(1683.4\ \text{keV}, 6^-\ 7^-) = 10.7 \pm 0.5$ nsec. These results imply $B(E2; 6^-,7^- \rightarrow 5^-) = 0.17 \pm 0.02\ (eb)^2$, $B(E1; 5^- \rightarrow 4^+) = (3.5 \pm 0.6) \times 10^{-7}\ e^2\ b$, and $B(M2; 5^- \rightarrow 4^+) = 0.033 \pm 0.008\ \mu_N^2\ b$. Experimental data are well reproduced by calculations based on the hole-core coupling model using a pairing residual force between proton holes. (auth)

8314 NEUTRON INELASTIC SCATTERING FROM ^{90}Zr. Glickstein, S. S.; Tessler, G.; Goldsmith, M. (Bettis Atomic Power Lab., West Mifflin, Pa.). Phys. Rev., C; 4: No. 5, 1818-28(Nov 1971).

Excitation functions were measured for γ-ray emission following neutron inelastic scattering from the 2.186-, 2.319-, 2.738-, 2.748-, 3.077-, 3.310-, and 3.84-MeV levels of ^{90}Zr for neutrons in the energy range 2.85 to 5.97 MeV. The γ rays were detected at 55° to the incident neutron beam by using an anti-Compton spectrometer consisting of a NaI(Tl) annulus enclosing a 45-cm^3 Ge(Li) detector. Multiple-scattering corrections were accounted for with the three-dimensional Monte Carlo code O5R. γ-ray angular distributions were calculated and used to deduce the total neutron inelastic scattering cross section from the cross section measured at 55°. These cross sections are in agreement with values calculated from Hauser–Feshbach theory corrected for level-width fluctuations and with previous measurements. (auth)

8315 HIGH-SPIN PROTON STATES OBSERVED IN THE REACTIONS ^{90}Zr(α,t)^{91}Nb AND ^{92}Mo(α,t)^{93}Tc AT 50 MeV. Zisman, M. S.; Harvey, B. G. (Univ. of California, Berkeley) Phys. Rev., C; 4: No. 5, 1809-17(Nov 1971).

The reactions ^{90}Zr(α,t)^{91}Nb and ^{92}Mo(α,t)^{93}Tc were investigated with a 50-MeV α-particle beam from the Berkeley 88-in. cyclotron. Comparisons are made with the results of (^{3}He,d) experiments on the same targets in order to locate high-spin (l > 2) levels in ^{91}Nb and ^{93}Tc. The ^{91}Nb(4.18 MeV) and ^{93}Tc(3.91 MeV) levels are probable l = 4 or 5 levels, in contrast to the (^{3}He,d) results. A difference in Q values for the reactions ^{90}Zr(α,t)^{91}Nb and ^{91}Zr(α,t)^{92}Nb of 680 ± 25 keV yields a Q value for the reaction ^{90}Zr(α,t)^{91}Nb of −14.643 ± 0.027 MeV, which is not consistent with the presently accepted mass excess of −86.750 ± 0.06 MeV for ^{91}Nb. (auth)

Nuclear Theory

Refer also to abstracts 7371, 7521, 7604, 7826, 7833, 7875, 7982, 8000, 8169, 8227, and 8230.

8316 (ITF–71-33-P) CALCULATION OF THE DEFORMATION PARAMETERS OF NUCLEI HAVING SPIN J = 0 IN A GROUND STATE. Dotsenko, I. S. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

It is shown that, by comparing the expressions for cross sections obtained on the basis of two different nuclear models, the deformation parameter of nuclei having spin J = 0 in the ground state may be expressed through the values of a microscopic model. This allows determination of the deformation parameter without comparing with experimental data. To illustrate, numerical calculation of the parameter β_2 of the ^{12}C nucleus is carried out. (auth)

8317 (ITF–71-64-P) THEORY OF (γ,p) REACTIONS AT THE ENERGIES ABOVE THE THRESHOLD OF PION PRODUCTION. Akhiezer, I. A.; Barts, B. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

Photonuclear reactions accompanied by escape of protons are investigated theoretically at energies above the threshold for pion production. In this region of energies the reaction $\gamma + A \rightarrow A' + p + \pi$ contributes essentially to the cross for cross section for (γ,p) reactions. The cross section for the above reaction is calculated in the impulse approximation in the Fermi gas model with self-consistent interaction. The dependence of the cross section on the parameters characterizing the nucleus is investigated. The results of the theory are compared with available experimental data. (auth)

8318 (LYCEN–7116) ELASTIC SCATTERING AND SEPARABLE NONLOCAL POTENTIALS. Barguil, Jacques (Lyon Univ. (France). Institut de Physique Nucleaire). May 1971. 105p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Lyon Univ. (France).

It is shown that elastic scattering by simple nuclei such as nucleon–nucleon, nucleon–^{4}He, or α–^{4}He are perfectly described using separable nonlocal potentials, even if internal structure effects exist. These potentials are realistic since they are in accordance with all the invariance conditions and hermicity required. Coulomb effects are introduced without great formal difficulties, and are completely justified in the study of low energy p–p scattering. With more complex nuclei these potentials are still satisfactory, when experiment permits the phase shifts to be determined, i.e., at low energy where there are not many partial waves. This is the case for α–^{12}C or α–^{16}O, where about 15 partial waves with energies in the 15 to 20 MeV region intervene but in which only particular waves have a significant effect. Even in the case where the number of parameters is restricted and the calculations are simple, it is useful to know the equivalent local potential. (France)

8319 (UCRL–20426, pp 96-149) NUCLEAR THEORY. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1971.

From Nuclear chemistry.

CALCIUM-42—helium-3 reactions (He-3,t) with, microscopic analysis of, (T)
FISSION—barrier calculations using droplet model, (T)
NUCLEAR MODELS—liquid-drop, comparison of truncated and conventional, (T)
—droplet, calculation of fission barrier for, (T)
NUCLEAR STRUCTURE—calculations for quadrupole and octupole states in deformed even–even nuclei, (T)
NUCLEAR THEORY—Thomas–Fermi calculation of nuclear properties
NUCLEI—nuclear radii and surface diffusion parameter for, determination from binding energy differences
OXYGEN-14—beta decay of, analysis using supermultiplet theory, (T)

RUTHENIUM-108—constrained Hartree–Fock calculation of single-particle energies, (T) (J.W.R.)

8320 ANALYTIC SOLUTIONS OF THE REFERENCE SPECTRUM EQUATION. Grypeos, M. E. (Democritus Nuclear Research Center, Athens). J. Math. Phys. (N. Y.); 12: No. 8, 1655-62(Aug 1971).

Analytic solutions of the fundamental equation of the reference spectrum method for nuclear matter are obtained in the cases of the square well and exponential potentials with hard cores. In the former case analytic wavefunctions are obtained for every partial wave L. These wavefunctions are expressed in terms of spherical Bessel and Hankel functions or in terms of spherical Bessel, Hankel, and Newmann functions of order L. In the latter case an analytic expression is obtained for the s wavefunction only. This is given in terms of the transcendental functions $G_{\ell v}(r)$ and $M_{\ell v}(r)$ which are defined as series of well-known functions. Finally an application is made of the results to the calculation of the well depth of a Λ particle in its ground state in nuclear matter. (auth)

8321 COLLECTIVE AND SINGLE-PARTICLE COORDINATES IN NUCLEAR PHYSICS. Zickendraht, W. (Univ., Marburg, Ger.). J. Math. Phys. (N. Y.); 12: No. 8, 1663-74(Aug 1971).

The Schrödinger equation of A nucleons is transformed to new coordinates. Six of them have collective nature and $3A - 9$ are single-particle coordinates. The connection is given to the conventional collective model in which five collective coordinates are used. The additional sixth collective coordinate of this paper gives a simple description of monopole vibrations. The new coordinates can also be used in the theory of nuclear reactions: By introducing a symmetrized distance vector for reaction partners, the antisymmetrization procedure is simplified considerably. (auth)

8322 ELEMENTS OF NEUTRON INTERACTION THEORY. Foderaro, Anthony. Cambridge, Mass.; Massachusetts Institute of Technology Press (1971). 596p. $19.95. (TID-25788).

Chapters are included on general features of interactions, classical collisions, elements of quantum mechanics, quantum mechanics of collisions, survey of neutron and nucleus properties and interactions, general theory of neutron-nucleus interactions, elastic scattering, inelastic scattering and cascade reactions, radiative capture, charged-particle emission, the fission reaction, and effects of target structure and atomic motion. (J.W.R.)

8323 EFFECTIVE α-NUCLEON INTERACTION IN NUCLEI. Batty, C. J. (Rutherford High Energy Lab., Chilton, Eng.); Friedman, E.; Jackson, Daphne F. Nucl. Phys.; A175: No. 1, 1-16(1971).

The microscopic model for elastic α-particle scattering from nuclei makes use of a parametrization of the effective α-nucleon interaction in nuclei. In this paper many sets of parameters have been considered in detail. Since the interaction takes place in the low-density region of the nucleus, each parametrization has been studied in relation to the free α-nucleon scattering, and the ability of some forms derived for the free α-nucleon interaction to describe the scattering of α-particles from nuclei has been checked. The results indicate that a consistent picture can be obtained and the effective interaction is quite well determined. (auth)

8324 STUDY OF THE UNIQUENESS OF THE R-MATRIX PARAMETERS WHEN FITTING CROSS-SECTION DATA USING A LEAST-SQUARE SEARCH ROUTINE. Auchampaugh, G. F. (Los Alamos Scientific Lab., N. Mex.). Nucl. Phys.; A175: No. 1, 65-72(1971).

A study of the uniqueness of the R-matrix parameters using the least-squares search routine MULTI has been made on mock two-, three-, five-resonance 1-spin-state data, and on ten-resonance 2-spin-state data. The study shows that the parameters E_λ, $\Gamma_{\gamma\lambda}$, $\Gamma_{n\lambda}$, and $\Gamma_{f\lambda} = \Gamma_{f1\lambda} + \Gamma_{f2\lambda}$ are unique and that the phase angles $\theta_{\lambda\lambda}$, obtained from a least-squares fit to data are not unique. The conclusion arrived at in the 2-spin-state study cautions against interpreting the results of a 2-channel, 1-spin-state fit to 2-spin-state data in terms of the possible spins of the resonances. (auth)

8325 PEAK-TO-TROUGH RATIO AND THE TWO-MODE-FISSION MECHANISM. Baba, H.; Baba, S. (Japan Atomic Energy Research Inst., Tokai). Nucl. Phys.; A175: No. 1, 199-216 (1971).

Peak-to-trough ratios were compiled and analyzed based on a model in which the two modes of fission were independently governed by two different saddles. The resulting barrier height for the symmetric mode of fission was found to be specified with two parameters, preferentially the mass and charge of the fissioning nucleus, instead of a single parameter as in the case of the asymmetric mode. The even-odd effect was not found in the former. The widths of the barriers, when approximated by parabolas, were concluded to be the same for the two modes. Calculation with the extended Jackson-Vandenbosch model gave consistent results. (auth)

8326 SELF-CONSISTENT CALCULATIONS OF THE NUCLEAR SURFACE. Keller, Hans Dieter (Univ., Cologne). Nucl. Phys.; A175: No. 1, 141-55(1971).

The surface energy and thickness of semi-infinite nuclear matter are calculated by the self-consistent Hartree-Fock method. The nucleon-nucleon potentials used here are the static soft-core potentials of Eikemeier and Hackenbroich. The repulsive cores are in part replaced by a short-ranged velocity-dependent two-body interaction to reproduce the correct nuclear-matter data. Tensor potentials are taken into account as effective first-order interactions. Swiatecki's variational method is found to be an inappropriate approximation for the interactions used here. Concerning the surface energy there is very satisfactory agreement with fits of the Bethe–Weizsäcker formula. The theoretically computed surface is always somewhat too diffuse (2.4–2.9 fm). But the calculated decrease of the surface thickness with increasing maximal density is in agreement with electron scattering data. (auth)

8327 PROGENITOR SUM-RULES IN NUCLEAR PHYSICS. Noble, J. V. (Univ. of Pennsylvania, Philadelphia. Univ. of Virginia, Charlottesville). Ann. Phys. (N. Y.); 67: No. 1, 98-113(Sep 1971).

The classic method for generating relations like the Thomas–Reiche–Kuhn dipole sum rule or the f-sum rule used in many-body theory is generalized. By considering the double commutators of various current-density operators, $J_a(q)$, with the nuclear Hamiltonian (i.e., $\{J_a(-q'), [H, J_b(q)]\}$) and concentrating on those which have simple forms, a more general class of sum rules than any previously applied to nuclear physics is established. These so-called "progenitor" sum rules act as generating functions for all the previously known sum rules. With the hypothesis that certain "giant" states saturate the sum rules, approximate dynamical relations between various form factors can be derived. Several examples are given by way of illustration, and some further applications are suggested. (auth)

8328 BETHE–GOLDSTONE EQUATION IN A FINITE NUCLEUS. Demos, Joslyn Raphael. College Park, Md.; Univ. of Maryland (1970). 144p. University Microfilms Order No. 71-12,174.

Thesis.

The Bethe–Goldstone equation is investigated with the effect of the projector Q included as accurately as possible by putting the equation into an iterative form. Q projects onto states where both particles have greater energy than the starting energy, and is diagonal in the relative coordinate space. Even if the correction terms are neglected, this equation is still a complicated integro-differential equation. A method has been found to solve this equation; this method involves little more work than solving the reference equation. The only correction term in the calculation of $\langle\Phi|G|\Phi\rangle$ was found to be very small in all cases except for the triplet S relative state, which can lead to a correction as big as .5 MeV in the energy levels. This effect has not been seen before. The results of the above equation are compared to several other common approximations of the Bethe–Goldstone equation. (TSS)

8329 SOME POSSIBILITIES TO SOLVE THE FADDEEV EQUATIONS WITH A POTENTIAL OF ARBITRARY SHAPE. Belyaev, V. B.; Zubarev, A. L. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 14: No. 3, 545-50(Sep 1971). (In Russian).

New modes of separable representation of the two-particle t matrix applicable at potentials of arbitrary shape are presented. A generalization of the Bateman method is given that enables one to carry out calculations using potentials with Fourier transforms that have no explicit form. On the basis of this method the tritium bound energy and the doublet nd scattering length are calculated with the Hulthen potential. Uniform convergence of the Bateman expansion is proved. (auth)

8330 SPIN-DEPENDENT SURFACE-DELTA INTERACTION FOR COLLECTIVE VIBRATIONAL NUCLEAR STRUCTURE IN DOUBLE-OPEN-SHELL EVEN–EVEN NUCLEI. Lin, Lu. Albany, N. Y.; State Univ. of New York (1971). 103p. University Microfilms Order No. 71-26,777.

Thesis.

The spin-dependent surface-delta interaction is used to study the collective behavior of the vibrational 2^+ excited states in terms of 2-quasi-particle excitations in double-open-shell even–even nuclei under the framework of Baranger's formalism. With a set of shell-model single-particle wave functions as a starting point, the Bogolyubov transformation is used to produce a quasi-particle representation and generate a state-independent pairing interaction. In the random phase approximation, the equations of motion of the 2-quasi-particle states are established and diagonalized. The coupling constant of the spin-singlet interaction is determined by the pairing force, and that of the spin-triplet interaction is chosen to fit the energy of the first 2^+ excited state. The B(E2) coefficients and the energies of the second 2^+ states are found to be in good agreement with experimental results. It is concluded that the spin-dependent surface-delta interaction, with appreciable magnitude of strength, does exist and can be responsible for the collective vibrational nuclear structure. (Diss. Abstr. Int., B)

8331 HIGH ENERGY COHERENT PROCESSES WITH NUCLEAR TARGETS. Moniz, E. J.; Nixon, G. D. (Stanford Univ., Calif.). Ann. Phys. (N. Y.); 67: No. 1, 58-97(Sep 1971).

The effects of nuclear structure on high-energy coherent reactions are investigated. To do this, the two-body correlation function for nuclear matter is computed; and a method for applying it to finite nuclei is given. A multiple-scattering description of elastic coherent processes in the presence of nuclear correlations is presented and generalized to inelastic coherent processes. This generalization includes the extra phase associated with the mass change of the projectile in diffractive production. The processes A(NN)A, $A(\pi\pi)A$, $A(\gamma\rho^0)A$, and $A(\gamma\gamma)A$ are analyzed using the same nuclear description for each, and the results are compared with experimental data. (auth)

8332 APPROXIMATE TREATMENT OF CORRELATIONS IN NUCLEAR SPECTROSCOPY: APPLICATIONS TO THE LEAD REGION. Vary, James Patrick. New Haven, Conn.; Yale Univ. (1970). 212p. University Microfilms Order No. 71-17,158. Thesis.

Motivated by the successes of the pairing-vibration model the two-nucleon Random Phase Approximation (2n RPA) is obtained in an operator approach using the equations of motion formalism and then applied to calculate properties of nuclei in the lead region. The spectra, boson amplitudes, single particle densities, spectroscopic factors and correlation energy resulting from the 2n RPA calculations are presented and compared with available experimental data and with results of the shell model (SM) limit. The boson amplitudes (2n RPA) and wave functions (SM) are then used in a numerical study of the (p,t) and $(^3He,p)$ reactions on a ^{206}Pb target to obtain information on the difference between the SM and the 2n RPA. (Diss. Abstr. Int., B)

8333 APPEARANCE OF PLATEAU IN THE NEUTRON TOTAL CROSS SECTION. Saharia, A. N.; Ahmad, I. (Aligarh Muslim Univ., India). pp 15-18 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8334 SPECTRAL AVERAGES FOR SINGLE-NUCLEON TRANSFER REACTIONS FOR NEUTRON-RICH-MULTI-SHELL TARGET STATES. Bansal, R. K. (Panjab Univ., Chandigarh, India). pp 93-6 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8335 CALCULATION OF THE REAL PART OF THE NUCLEON-NUCLEUS OPTICAL POTENTIAL. Kidwai, H. R.; Rook, J. R. (Nuclear Physics Lab., Oxford). pp 97-101 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8336 OPTICAL POTENTIAL FOR DEUTERON. Samaddar, S. K.; Mukherjee, Suprokash (Saha Inst. of Nuclear Physics, Calcutta). pp 105-9 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8337 CONFIGURATION MIXING VS. EFFECTIVE SHELL MODEL. Gupta, Raj K.; Bansal, Ram K. (Panjab Univ., Chandigarh, India). pp 149-52 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8338 CHARACTERISTICS OF $\alpha-\alpha$ INTERACTION. Joshi, P C.; Sood, P. C. (Banaras Hindu Univ., India). pp 201-6 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8339 SHELL MODEL DESCRIPTION OF $(5/2)^n$ CONFIGURATIONS OF IDENTICAL PARTICLES. Nigam, A. K.; Sood, P. C. (Banaras Hindu Univ., India). pp 207-12 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol. 2).

8340 DEPENDENCE OF NUCLEAR MATTER BINDING ENERGY ON THE HIGH ENERGY PHASE SHIFTS. Srivastava, M. K. (Univ. of Roorkee, India). pp 221-5 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8341 MODEL INDEPENDENT NO PARAMETER ANALYSIS OF SINGLE PARTICLE LEVELS OF LIGHT NUCLEI USING THE PHASE SHIFT METHODS OF ELLIOTT. Dey, Jishnu (Chandernagore Coll., Hooghly, India). pp 231-5 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8342 UNIFIED THEORY ON THE STRUCTURE OF ATOMS AND NUCLEI. Ramanna, R.; Jyothi, S. (Bhabha Atomic Research Centre, Bombay). pp 239-49 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8343 SCHEMATIC DESCRIPTION OF COLLECTIVE STATES OF NUCLEI. Sharma, S. K.; Bhatt, K. H.; Khadkikar, S. B. (Physical Research Lab., Ahmedabad, India). pp 255-9 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8344 FISSION PROPERTIES OF SUPERHEAVY NUCLEI. Ramamurty, S.; Ramanamurty, M. V.; Parthasaradhi, K.; Chandran, C. R. (Andhra Univ., Waltair, India). pp 263-6 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8345 LEVEL DENSITY PARAMETERS AND NUCLEAR STRUCTURE. Ramamurty, S.; Parthasaradhi, K.; Ramanamurty, M. V.; Chandran, C. R. (Andhra Univ., Waltair, India). pp 267-9 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8346 SHELL EFFECTS ON NUCLEAR LEVEL DENSITIES. Ramamurthy, V. S.; Kapoor, S. S.; Kataria, S. K. (Bhabha Atomic Research Centre, Bombay). pp 271-7 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8347 PRODUCTION POSSIBILITY OF SUPERHEAVY NUCLEI. Ramamurthy, V. S.; Kapoor, S. S. (Bhabha Atomic Research Centre, Bombay). pp 279-85 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8348 EFFECT OF HEXADECAPOLE DEFORMATION ON NILSSON ORBITAL CROSSING. Ramakrishna, G. (Saha Inst. of Nuclear Physics, Calcutta). pp 289-94 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8349 SYSTEMATICS OF ROTATIONAL NUCLEI ON THE BASIS OF TWO-CENTRE MODEL. Prakash, V. R.; Bahal, B. M.;

Deshpande, V. K. (Indian Inst. of Tech., Kanpur). pp 295-9 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8350 SU_3 SYMMETRY IN f-p SHELL. Kulkarni, D. R.; Bhatt, K. H. (Physical Research Lab., Ahmedabad, India). pp 321-4 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8351 DEEXCITATION PHENOMENA IN PROMPT FISSION FRAGMENTS. Sarkar, Ratna; Chatterjee, Aparesh (Saha Inst. of Nuclear Physics, Calcutta). pp 619-22 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8352 SOME QUALITATIVE ASPECTS OF THE LOCAL IMAGINARY POTENTIAL. Ahmad, I.; Rahman Khan, M. Z. (Aligarh Muslim Univ., India). pp 623-6 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8353 NEUTRON DISTRIBUTION IN NUCLEI FROM ISOBARIC ANALOGUE STATES. Murthy, M. (Indian Inst. of Tech., Kanpur). pp 639-42 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8354 COMPARISON OF THE CENTRIFUGAL STRETCHING MODEL AND THE VARIABLE MOMENT OF INERTIA MODEL. Sood, P. C. (Banaras Hindu Univ., India). pp 643-6 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8355 SOLUTION TO A PROBLEM IN CONSTRAINED HARTREE-FOCK AND OTHER CALCULATIONS. Bassichis, W. H.; Wilets, L. (Univ. of California, Livermore). Phys. Rev. Lett.; 27: No. 21, 1451-4(22 Nov 1971).

In the method of Lagrange multipliers in constrained variational calculations, certain regions of interest have in the past been inaccessible. A modified procedure is proposed which, as is shown both algebraically and numerically, circumvents this difficulty. (auth)

8356 APPROXIMATE ANALYTICAL FORM OF SINGLE-PARTICLE WAVE FUNCTIONS OF NUCLEONS IN A SAXON-WOODS POTENTIAL. Belousova, V. I.; Rudak, E. A.; Khil'manovich, A. M. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 3, 112-14(1971). (In Russian).

The possibility of approximations in the numerical solution of the Schroedinger equation was examined with the help of analytical functions. Results of approximations of accurate solutions are presented for the nuclei ^{38}Cl, ^{92}Nb, ^{209}Pb, and ^{210}Bi. (tr-auth)

8357 NUCLEAR-MATTER CALCULATIONS USING THE Λ_{00} AND Λ_{10} THEORIES. Foster, T. C.; Fiset, E. O. (Los Alamos Scientific Lab., N. Mex.). Nuovo Cim.; 6A: No. 2, 129-33(21 Nov 1971).

The ground-state properties of nuclear matter are calculated using the Λ_{00} and Λ_{10} approximations. A nucleon-nucleon interaction was chosen to be the same as that used by Wegman and Weigel in a Λ_{11} calculation. (auth)

8358 BOSON DESCRIPTION OF COLLECTIVE STATES. I. DERIVATION OF THE BOSON TRANSFORMATION FOR EVEN FERMION SYSTEMS. Janssen, D. (Central Inst. for Nuclear Research, Rossendorf, Ger.); Doenau, F.; Frauendorf, S.; Jolos, R. V. Nucl. Phys.; A172: No. 1, 145-65(1971).

Using the algebraic method of Marumori et al. an extension of the boson representations of Holstein and Primakoff and Dyson for spin operators is given for the case of fermion pair and density operators. Furthermore it is demonstrated that an equivalent formulation arises when the generator-coordinate method is applied. Using Dyson's concept in an exact way a finite boson expansion of the fermion pair and density operators is derived. As a consequence the resulting Hamiltonian contains the boson operators at most in sixth order. However this Dyson transformation is not unitary and therefore the Hamiltonian is not hermitean. Thus the diagonalization of the Hamiltonian leads to a bi-orthogonal set of eigenstates. Similar to the Dyson theory these states contain components which violate the Pauli principle. The problem of the separation of the "physical" and "unphysical" components has been solved by the introduction of a non-linear boson transformation. (auth)

8359 FIRST-ORDER SHELL-MODEL RENORMALIZATION IN THE 1s-Od SHELL. Goode, Philip (Univ. of Rochester, N. Y.). Nucl. Phys.; A172: No. 1, 66-80(1971).

It is shown that in the first-order renormalization of the two-body matrix elements in the 1s-0d shell, one must take care in the treatment of the ^{16}O core. Explicitly, when the ^{16}O core is treated as being unperturbed or perturbed in the complete $2\hbar\omega$ shell-model space, the results of the renormalization are essentially the same. However, if one treats the ^{16}O core in the Tamm-Dancoff (TDA) subspace of the $2\hbar\omega$ model space, the results of the calculation are quite different. The origins of these effects are discussed. The renormalization of the E2 operator is also discussed. (auth)

8360 CONSISTENT MICROSCOPIC DESCRIPTION OF ROTATIONAL MOTION IN EVEN-EVEN DEFORMED NUCLEI. Yamamura, Masatoshi (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 1, 148-66(Jul 1971).

The idea of using sum rules expressing different single-particle transition operators in terms of higher powers of other operators, recently devised by D. H. E. Gross and the present author, is applied to the description of nuclear rotational motion in a proton-neutron system. For simplicity, we restrict ourselves to the single j_p-and j_n-shell model with a quadrupole interaction. Moments of inertia, quadrupole moments, transition probabilities and collective g-factor show excellent agreement with those given by the cranking model. (auth)

8361 CALCULATION OF DENSITIES OF LIGHT NUCLEI. Hutzelmeyer, Hannes (Univ., Cologne). Z. Phys.; 247: No. 5, 444-52(1971).

For certain classes of wave functions one can calculate the exact expressions of the charge distribution and similar densities. One has to make use of the asymptotic behavior of these wave functions (whose radial parts have to be of the form $r^{2k}e^{-\beta r^2}$) in order to obtain a closed form for p(r); the problem is then reduced to the computation of moments, which can be evaluated by a generating-function technique. No complications due to a spurious center-of-mass motion appear. The method is most appropriate for the calculation of densities of refined cluster-model functions or translationally invariant shell-model functions (both for a nucleon or an α-particle shell model) including short-range correlation factors that take care of a soft core in nuclear potentials. (auth)

8362 BOSON EXPANSIONS FOR FERMION PAIR OPERATORS: THE SINGLE j LEVEL. Li, Shou Yung (Univ. of Rochester, N. Y.); Dreizler, R. M.; Klein, Abraham. Phys. Rev., C; 4: No. 5, 1571-91(Nov 1971).

A new version of a method due originally to Marumori [Progr. Theor. Phys. (Kyoto) 31: 1009(1964)] for the representation of fermion pair operators as expansions in boson variables is developed and applied to nucleons confined to a single j shell. In the present formulation, a seniority basis of good angular momentum states is imaged in a subspace of the boson space—the physical boson space—characterized by the same quantum numbers. This transformation has the following properties, only the first of which is shared with previous work: Pauli-principle restrictions are satisfied; the fermion pair operators approach the leading terms of their expansions as $j \to \infty$; for fixed j one can identify maximal subspaces of the physical boson space in which the boson expansions converge and which define the maximum extent to which the model physical system can exhibit vibrational behavior. An extension appropriate to systems with an odd number of nucleons is also described. By consideration of the direct product, the method described here should be useful for shell-model calculations of a restricted set of states for large particle number. (auth)

8363 CLUSTER EXPANSIONS FOR CORRELATED WAVE FUNCTIONS OF FINITE SYSTEMS. da Providencia, Joao; Shakin, C. M. (Univ., Coimbra). Phys. Rev., C; 4: No. 5, 1560-3 (Nov 1971).

A theory of correlated wave functions for finite systems is developed which systematically neglects the contribution from three-body cluster terms. The approximation made leads to a derivation of a Bethe-Goldstone equation for finite systems that includes modified occupation probabilities and self-consistent potentials for occupied states. The absence of potentials in unoccupied states follows from the neglect of three-body cluster terms. It is also shown that a careful treatment of the Pauli principle and occupation probabilities allows the application of variational techniques. (auth)

8364 MATHEMATICALLY ALLOWED NONPHYSICAL PHASE-SHIFT SOLUTIONS. Bernstein, E. M.; Ramirez, J. J. (Western Michigan Univ., Kalamazoo). Phys. Rev., C; 4: No. 5, 1504-7(Nov 1971).

An angular distribution for $^{12}C(\alpha,\alpha)^{12}C$ near the center of a resonance can be fitted with any value for the real part of the resonating nuclear phase shift. This surprising result is in agreement with resonance theory and occurs because the elastic width of the resonance is $\frac{1}{2}$ of the total width. In general, in a phase-shift analysis the real part of the nuclear phase shift will be indeterminate whenever the inelastic parameter is zero. (auth)

8365 EVIDENCE FOR ANOMALOUS g_l FACTORS OF THE NUCLEONS AND THE MESONIC-EXCHANGE EFFECT. Nagamiya, S.; Yamazaki, T. (Tokyo, Univ.). Phys. Rev., C; 4: No. 5, 1961-4(Nov 1971).

Evidence for anomalous g_l factors of the nucleons over the whole mass region is presented. The analysis yields $g_l^{eff}(p) = 1.09 \pm 0.03$ and $g_l^{eff}(n) = -0.06 \pm 0.04$, which are compatible with the effect of the mesonic-exchange current. (auth)

8366 DEPTH OF THE NUCLEAR POTENTIAL WELL IN HEAVY-ION SCATTERING. Toepffer, Christian (Univ., Frankfurt am Main). Phys. Rev., C; 4: No. 5, 1964-5(Nov 1971).

The increase of the depth of nuclear potential wells and of the nucleon–nucleon attraction upon compression of nuclear matter is estimated. (auth)

PHYSICS (PLASMA AND THERMONUCLEAR)

Confinement and Heating

Refer also to abstracts 8418 and 8437.

8367 PLASMA COMPRESSION APPARATUS. Uleski, Robert E. U. S. Patent 3,614,525. 19 Oct 1971. Filed 14 Jan 1969.

Apparatus to compress a plasma or ionized medium by the use of a generally spherical field produced by a generally spherical winding or field means is described. The current flows generally in the same direction on the conductors that surround an envelope containing the plasma to produce a weak field or null field in the central region of the envelope, with a stronger field surrounding this weak field that effectively compresses the plasma into the central region. (auth)

8368 IMPROVEMENTS IN OR RELATING TO PLASMA CONFINEMENT APPARATUS. Watson, Christopher John Hamilton (to United Kingdom Atomic Energy Authority). British Patent 1,252,906. 10 Nov 1971. Filed 21 Jan 1969.

The principle on which the system described is based is that, using rf fields that are nearly but not exactly in resonance with the ion cyclotron frequency, there is a substantially smaller transfer of energy to the plasma. On a single-particle model such nearly resonant fields lead to a reversible increase in the transverse energy of the ions as they approach resonance, but this energy is returned to the rf field as the particle leaves the resonance zone, after reflection by the magnetic field gradient. The apparatus described comprises a vessel for containing low-pressure gas, means for forming in or introducing into the vessel a plasma, and means for forming a static magnetic field for confining the plasma. This magnetic field has one or more loss regions within which the lines of force leave the contaminant vessel, with means for localizing in these regions rf electromagnetic radiation, the frequency of which is greater than the peak ion cyclotron frequency and near to but not exactly in resonance with the ion cyclotron frequency, the electromagnetic radiation tending to reflect back into the confined plasma ions moving out of the static magnetic field through the loss regions. (UK)

8369 NEW TYPES OF RESONANCE SYSTEMS FOR HIGH-FREQUENCY HEATING OF PLASMA. Longinov, A. V.; Nizhnik, G. Ya. Vestn. Khar'kov. Politekh. Inst.; No. 50, 105-10 (1970). (In Russian).

Systems are described for the introduction of high-frequency energy into a plasma, significantly increasing the power transmitted. The introduction coil is fashioned into two coils composed of sectors; the sectors of one coil are connected with the sectors of the other coil through condensers, and the azimuthal gap of one group of sectors faces the center of a sector of the other group. A formula is given for the resonance frequency of this arrangement. The distribution of the high-frequency magnetic field was plotted along the axis of the system. The system as described makes possible the use of hundreds and thousands of megawatts for resonant heating. (K.S.W.)

8370 GENERAL EQUATIONS OF LASER HEATING OF D–T PLASMA, THE HEAT OF THERMONUCLEAR FUSION BEING TAKEN INTO ACCOUNT. Kaliski, S. (Inst. of Fundamental Tech. Problems, Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Tech.; 19: No. 6, 485-91(1971).

General equations (nonaveraged) of laser heating and D–T plasma expansion are derived; generation of heat during the process of thermonuclear fusion is taken into consideration. The problem set consists in formulation of a nonlinear system of partial equations with retarded argument, which depends in a nonlinear manner on the solutions. The system of equations considers the effect of electron thermal conduction, bremsstrahlung shock waves, and also an effect of heat generated by thermonuclear fusion, etc. The general system of equations is extremely complex. In particular cases, in dependence on the numerical relations among the parameters of the problem, the system of equations may be sometimes greatly simplified. Particular cases of solutions are considered separately. (auth)

8371 ANALYSIS OF HEATING AND CONFINEMENT OF PLASMAS BY RADIO-FREQUENCY ANTENNA SYSTEMS. Arendt, Paul Nelson. Columbus, Ohio; Ohio State Univ. (1971). 126p. University Microfilms Order No. 71-27,417.

Thesis.

An investigation of radio-frequency heating and confinement of plasmas was made using numerical analytical techniques. Three rf antenna systems designed provided a stable energy-limited plasma in a radially varying external magnetic field. When small-angle Coulomb scatterings with ion densities of 10^{14} cm^{-3} were introduced into the calculations, no significant changes in the overall heating and confinement properties of the systems occurred. Charge separation between portions of the plasma cross section was essentially nonexistent; the scattering and diffusion of ions from the plasma region was nearly eliminated. The collisional energy distribution of the plasma was obtained and used to calculate the self magnetic field and the fusion power density of the plasma. The fusion density was found to be comparable to that of fission reactors at densities of 10^{14} cm^{-3}. (Diss. Abstr. Int., B)

8372 INVESTIGATION OF CONDITIONS FOR HEATING DENSE PLASMA FORMED BY INJECTING ELECTRON BEAMS INTO MAGNETIC TRAPS. Bredikhin, M. Yu.; Maslov, A. I.; Skibenko, A. I.; Skibenko, E. I.; Yuferov, V. B. (Physical-Technical Inst., Kharkov. Kharkov State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 7, 1180-5(Jul 1971). (In Russian).

The dense plasma was formed by injecting a high-energy electron beam into a magnetic trap. The heating efficiency depends upon the magnetic field magnitude, cross velocity of the electron beam, and ratio of electron Langmuir and electron Larmor frequencies. (auth)

Diagnostics

8373 STAGNATION PROBE MEASUREMENTS IN FLOWING PLASMAS. Clements, R. M. (Univ. of Victoria, British Columbia); Smy, P. R. J. Phys., D (London); 4: No. 11, 1687-94(Nov 1971).

Measurements of the ion current to a circular flat stagnation probe were performed in a laboratory flame of known ionization density. The measurements were performed over an ionization density range from 10^{15} to 10^{18} m^{-3}, probe bias voltages from 5 to 400 V and probe/flame velocities from 3 to 19 m s^{-1}. The measurements show good agreement with the calculated sheath/convection currents: $I = (VR)^{0.8}(n_e e u_\infty)^{0.6}\pi(6\epsilon_0\mu)^{0.4}$ (mks) for the case where the sheath is thick compared with the probe, and $I = (72R^8 n_e{}^3 e^3 u_\infty{}^3 V^2 \mu\epsilon_0\pi\alpha^{-3})^{0.25}$ (mks) for the case where the sheath is thin compared with the probe. Here R is the radius of the flat conduction face of the probe, n_e the ionization density, e the electronic charge, μ the ion mobility, u_∞ the plasma flow velocity relative to the probe, far from the probe, V the probe bias voltage, ϵ_0 the permittivity of free space, and α the radius of the insulator surrounding the conducting face of the probe. (auth) (UK)

8374 COMPARISON OF PLASMA-DENSITY MEASUREMENTS MADE WITH A DOUBLE PROBE, A RESONANT CAVITY TECHNIQUE, AND AN UPPER HYBRID FREQUENCY METHOD. Keen, B. E.; Fletcher, W. H. W. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). J. Phys., D (London); 4: No. 11, 1695-1701(Nov 1971).

Plasma density measurements taken simultaneously on a plasma column by three different techniques are reported. The diagnostic methods used were a double-probe method, a resonant microwave-cavity technique, and an upper-hybrid-frequency method. The density range covered was 10^9 to 10^{11} cm^{-3}, and the plasmas employed were rf discharges in the lower-density range and the positive column of arc discharges in the higher-density range, each running in hydrogen, helium, neon, or argon gas. It is shown that, if sufficient care is taken and corrections are applied, reliable results can be obtained. Further, reasonably good agreement (±25%) can be achieved between the three methods under these circumstances. (auth)

8375 THERMAL BOUNDARY-LAYER EFFECTS ON LANGMUIR PROBE MEASUREMENTS IN FLOWING GASES. Pert, G. J. (Univ. of Hull, Eng.). J. Phys., D (London); 4: No. 11, 1702-9(Nov 1971).

The flow of a weakly ionized gas past a planar probe is considered. In order to assess the errors incurred using the standard uniform-electron-temperature models, calculations are made of the electron temperature in the boundary layer under conditions of subsonic low-temperature plasma flow typical of flames. It is found that, for the usual experimental case of small currents, the electron temperature is only uniform if the parameter $\alpha/a \lesssim 0.2$, and is equal to the wall temperature if $\alpha/a \gtrsim 10$. The parameter α^2 is equal to the ratio of the gas flow time past the probe to the characteristic electron cooling time, and a is the reduced gas temperature gradient at the wall. (auth)

8376 MASS SPECTROSCOPIC DIAGNOSTICS OF THE VACUUM ARC. Venkatasubramanian, V. S.; Rajagopalan, P. T. (Indian Inst. of Science, Bangalore). pp 545-50 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8377 TEMPERATURE EFFECTS ON ELECTROSTATIC PROBE MEASUREMENT IN HIGH PRESSURE PLASMA. Rohatgi, V. K. (Bhabha Atomic Research Centre, Bombay). pp 601-6 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8378 VELOCITY MEASUREMENT IN RF PLASMA JET. Jayakumar; Paithankar, A. S. (Bhabha Atomic Research Centre, Bombay). pp 607-10 of Proceedings of the Nuclear Physics and Solid State Physics Symposium. Vol. II. Bombay; Department of Atomic Energy (1970).

From Nuclear physics and solid state physics symposium; Madurai, India (27 Dec 1970). See CONF-701219-(Vol.2).

8379 DISTORTION OF DISTRIBUTION FUNCTION OF ELECTRONS WITH RESPECT TO ENERGIES MEASURED BY A CYLINDRICAL PROBE. Lukovnikov, A. I.; Novgorodov, M. Z. Kratk. Soobshch. Fiz.; No. 1, 27-34(1971). (In Russian).

The electron distribution function was determined using a cylindrical probe. A theoretical analysis showed that the distortion effect of the probe was conditioned by the final diffusion rate. (auth)

8380 RADIATIVE RECOMBINATION. Seaton, M. J. (University Coll., London). Comments At. Mol. Phys.; 3: No. 1, 15-22(Oct-Nov 1971).

It is stated that the process of radiative capture of an electron by an ion to produce an atom in an excited state can be studied in a plasma by observing the intensity of the radiation subsequently emitted in spectral lines, and it can also be studied by observing the ionization equilibrium in a plasma, or the rate of plasma decay. A discussion is presented of some situations that arise in low-density H_2 plasmas. Among matters considered are collisional-radiative decay, dielectronic recombination, and collisional-dielectronic recombination. 7 references. (UK)

8381 ION COLLECTION BY MEANS OF LANGMUIR PROBES. Shih, Chia-hsin. Brooklyn; Polytechnic Inst. of Brooklyn (1971). 131p. University Microfilms Order No. 71-29,107.

Thesis.

The effect of collision on the steady-state collection of cold ions by means of Langmuir probes is investigated. A simple theory that accounts separately for the effect of collisions between charged particles and collisions with neutrals is presented. When this theory is applied to recent experimental data taken with cylindrical as well as spherical probes, the electron densities calculated from the probe measurements by using the present theory agree within 10% with those inferred from existing numerical solutions, an empirical formula, and microwave cavity data. The same theory can also be applied to determine the characteristic parameters (λ_i, ν_{in}) for ion–ion and ion–neutral collisions, and to deduce related quantities, such as the ion temperature, the chemical composition of the plasma, and the density of the neutral background gas. The method for the determination of T_i is applied to experiments conducted at PIB. The calculated temperatures (50° to 60°K) agree reasonably well with the reported temperature (70°K). The method for the determination of ν_{in} is applied to experiments conducted at Stanford University. The results agree with those deduced from mobility calculations within 20%. Transient performance is investigated next. Every change in the operating conditions of the probe brings about a redistribution of the charges within the sheath. The resulting displacement component of current adds up to the convective component considered by the steady-state theory. The present analysis shows that the displacement component of current becomes appreciable when the change in operating conditions occurs in times of the order of the transit time of the ions through the sheath. As a consequence the relaxation time of the sheath depends on the sheath thickness and, therefore, on the probe bias, the ohmic drop, and the sign of the charge. It is found that the dynamic response of the sheath thus sets an upper limit for the validity of the steady-state theory at a frequency between one and two orders of magnitude below the ion plasma frequency. The understanding of the dynamic performance of the sheath leads to the correct interpretation of probe measurements in turbulent plasmas. In the frequency range where the convective component of current is predominant, the nonlinearity of the I–V characteristic causes both a shift in the dc level and a distortion of the ac spectrum. These are determined quantitatively in their overall effect and then related to the individual types of fluctuations (potential, density, temperature and velocity), and their auto and cross correlations. In the high-frequency range the dynamic performance of probes of various geometries is studied in terms of appropriate equivalent circuits. (Diss. Abstr. Int., B)

8382 DEVELOPMENT OF A NEW PLASMA DIAGNOSTIC TECHNIQUE USING SLOW POSITRONS. Lohnert, Gunter H.; Schneider, Richard T. (Univ. of Florida, Gainesville). J. Appl. Phys.; 42: No. 12, 4799-4807(Nov 1971).

Interaction of positrons with a plasma allows investigations of plasma parameters such as density, temperature, and velocity distribution of the electrons. In order to obtain detectable effects for the positron-plasma interactions, a beam of slow positrons has to be used. The measurement of positron lifetime in the plasma and measurement of the angular correlation of the annihilation radiation yield information on electron density and temperature. A parallel beam of slow positrons injected into a plasma is spread into an angle $\langle\alpha\rangle$ after leaving the plasma due to the cumulative effect of small-angle scattering of the positrons with the microfield of the plasma. In measuring $\langle\alpha\rangle$, the microfield, and hence the electron density, can be found. A rigorous derivation of the average scattering angle of the positrons as a function of the electron density and gas pressure is developed. The theoretical results are applied to a special test plasma. A device was designed and constructed which is capable of producing a beam of slow positrons. Both ^{22}Na and ^{58}Co are possible commercially available positron sources. Employing a ^{22}Na source of 2 mCi, the device produces 1850 slow positrons per second, at a beam radius of 1.9 mm. In order to verify the theoretical expression for the beam spread and to demonstrate the feasibility of the new plasma diagnostic technique, a He plasma (14-cm diameter) was used as a test object. The slow positrons were injected into the plasma from a high-vacuum system into the plasma chamber through an ultrathin window (200 Å). The results of the beam-spread measurements were compared with spectroscopic and probe measurements. Good agreement was found. (auth)

8383 NEW ELECTROSTATIC REFRACTION PROBE FOR MEASURING PLASMA PARAMETERS. Kuswa, Glenn W. (Univ. of Wisconsin, Madison). J. Appl. Phys.; 42: No. 12, 4817-20 (Nov 1971).

A new probe, employing the refraction of charged particles as they cross the potential interface from a plasma to the screened end of a pipe, containing a single-collection electrode, is described. It is capable of determining T_e, T_i, n, and the plasma potential φ_p of Maxwellian plasmas by straightforward techniques using two simple expressions. Experiments were performed to compare refraction probe measurements with data obtained by Langmuir probe and electrostatic curved-plate energy-analyzer techniques. (auth)

8384 SPATIAL CONDUCTIVITY MEASUREMENTS IN TURBULENT PLASMAS. Korn, P.; Wharton, C. B. (Cornell Univ., Ithaca, N. Y.). J. Appl. Phys.; 42: No. 12, 4828-31(Nov 1971).

The design of an rf conductivity probe for measurements in transient plasmas is described. Calibration is performed using electrolytic solutions of known conductivity determined from a standard cell in a resistance bridge. The spatial resolution of the probe is determined, and conductivity measurements of a high-density plasma in a magnetic mirror prior to and following turbulent heating are presented. (auth)

8385 DIAGNOSTICS OF NON-NEUTRAL PLASMAS USING AN INDUCED-CURRENT ELECTROSTATIC PROBE. Kapetanakos, C. A.; Trivelpiece, A. W. (Univ. of Maryland, College Park). J. Appl. Phys.; 42: No. 12, 4841-7(Nov 1971).

The charge induced on an insulated conductor by a nonneutral collection of charged particles furnishes information about the macroscopic motion of such a system. Expressions for the current induced in probe by circular motion of a charged rod are derived and compared with results obtained in a nonneutral plasma confinement experiment to illustrate the usefulness of this technique. (auth)

8386 MEASUREMENT OF THE ENERGY DISTRIBUTION FUNCTION OF THE ELECTRONS OF AN INDUCTIVE hf DISCHARGE IN HYDROGEN USING THE ASYMMETRIC TRIPLE PROBE METHOD. Turban, Guy (Univ., Nantes, France). Compt. Rend., Ser. B; 273: No. 14, 584-7(4 Oct 1971). (In French).

The asymmetric triple-probe method was used to study a hydrogen plasma produced in an inductively coupled hf discharge. The pressure varied between 0.1 and 0.01 torr, and the excitation frequency was 5.2 MHz. The results are compared with those obtained with a double probe. Measurement of the distribution function using the Druyvesteyn method enabled the deviation from the Maxwellian distribution to be observed. (France)

8387 POSITIVE ION SHEATH OF A PLANE PROBE IMMERSED IN A PLASMA. Sen, C.; Basu, J. (Saha Inst. of Nuclear Physics, Calcutta). Jap. J. Appl. Phys.; 11: No. 1, 113-14(Jan 1972).

An investigation was made of the relation between probe potential and sheath thickness. Poisson's equation for the collisionless sheath of a negative plane probe was used in the analysis. (M.O.W.)

8388 SIDE ON INTERFEROMETRY AT 10.6 μm OF THETA PINCH PLASMAS. Daerr, A.; Decker, G.; Roehr, H. (Max-Planck Inst. fuer Plasmaphysik, Garching, Ger.). Z. Phys.; 248: No. 2, 121-9(1971).

An experiment for measuring electron density spatially resolved with high time resolution is described. The experiment was performed side on on a theta-pinch plasma. The light source (TEA-CO_2 laser), the window problem, the area detector for the interferogram are discussed. The sensitivity of the technique is 1 to 2×10^{15} electrons/cm^2. Some examples of measured density profiles show that the method may be used effectively on toroidal plasma machines. (auth)

8389 DETECTION OF ACOUSTIC WAVES IN A SEEDED PLASMA FLAME BY MODULATION OF THE VOLTAGE-CURRENT CHARACTERISTICS OF AN ELECTROSTATIC PROBE. Sinitean, D. D. (Univ., Timisoara, Rumania). Compt. Rend., Ser. B; 273: No. 6, 265-8(9 Aug 1971). (In French).

The possibility of detecting an acoustic wave in the plasma of a CH_4-O_2 flame, seeded with potassium, by modulation of the voltage–current characteristics of a fixed electrostatic probe, was demonstrated. Detection, in this way, is not possible with moving probes (i.e., by the method of Clements and Smy). (France)

Kinetics (General)

8390 VOLT–AMPERE CHARACTERISTICS OF THE PLASMA VARACTOR. Brandt, A. A.; Tikhomirov, Yu. V. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 3, 355-6(May-Jun 1971). (In Russian).

The plasma varactor is characterized by a nonlinear capacity, and a plasma forms at certain boundaries. The application of a high-frequency voltage to modify the basic characteristics is discussed. The volt–ampere relationships in the plasma varactor are shown graphically as a function of various superhigh-frequency voltages, ranging from 10 to 72 volts. The dependence of constant current and constant voltage of the second harmonic on constant electrode voltage for the varactor is also shown and discussed. (K.S.W.)

8391 ELECTRIC DISCHARGES IN VACUUM. INITIATION OF THE VACUUM ARC. Rohrbach, F. (European Organization for Nuclear Research, Geneva). Rev. Gen. Elec.; 80: No. 7, 577-80(Jul 1971). (In French).

The principal mechanisms leading to vacuum arcs are discussed. They are classified into three categories: mechanisms based on field emission, mechanisms based on the existence of microparticles, and mechanisms based on a cumulative exchange between charged particles. (France)

8392 ELECTRIC DISCHARGES IN VACUUM. LIMITATIONS OF HF CAVITIES. Leroy, D. (European Organization for Nuclear Research, Geneva). Rev. Gen. Elec.; 80: No. 7-8, 581-2 (Jul-Aug 1971). (In French).

Electric breakdowns induced in superconducting cavities by an avalanche effect (multipactoring) and field-emission effects are discussed. Experimental results are presented, and the advantages of using Nb to construct such cavities are discussed. (France)

8393 PLASMA PHYSICS AND FUSION REACTOR. Lehner, Guenther W.; Schlueter, Arnulf (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Elektrotech. Z., A; 92: No. 5, 249-57(1971). (In German).

Plasmas are surveyed with respect to general properties, electric conductivity, behavior in magnetic fields, instabilities, and collective effects. Subsequently, the fusion problem is discussed. Also discussed are fusion reactions, fusion arrangements, magnetic containment of plasmas in open devices, and magnetic containment of plasmas in closed devices. Equipment at the Max Planck Institute for Plasma Physics is described and depicted. (H.B.G.)

8394 DIFFERENT ABSORPTION AND EMISSION LINE SHAPES FOR STARK-BROADENED RESONANCE LINES IN HELIUM PLASMAS. Griem, H. R. (Univ. of Maryland, College Park). Comments At. Mol. Phys.; 3: No. 1, 1-3(Oct-Nov 1971).

Pressure-broadened spectral lines are usually assumed to have essentially the same shapes in absorption and emission, except for differences in asymmetry corrections. It is shown, however, for the wings of Stark-broadened resonance lines of ionized He in a singly ionized He plasma, that significantly different absorption and emission line shapes might occur, and it is concluded from the discussion that in the case of the resonance line absorption and emission line shapes differ in circumstances where their equality is generally accepted. This effect can be made use of to measure total cross sections against electron collisions for ions in excited states. 3 references. (UK)

8395 BALL LIGHTNING AND THERMOLUMINESCENCE. Mills, A. A. (Univ. of Leicester, Eng.). Nature (London) Phys. Sci.; 233: No. 42, 131-2(18 Oct 1971).

It has been suggested that the source of energy in ball lightning might be nuclear, and in this connection it was suggested that the thermoluminescent properties of masonry in the vicinity of a ball lightning strike should be examined. A church in Leicester, of which the steeple was demolished by a violent storm in 1846, during which a globular mass of fire was observed, was thought to represent a suitable site. Samples were taken from the original uppermost stones of the steeple, which had been preserved, and examined in the conventional manner for thermoluminescence. There was no evidence of increased thermoluminescence from any part of the steeple material. The samples were also examined by ESR techniques, and no evidence of exposure to an intense source of radiation was obtained. (UK)

8396 PARAMETRIC AMPLIFICATION OF A SIGNAL WITH A FREQUENCY GREATER THAN THAT OF THE PUMPING WAVE IN A PLASMA-BEAM MEDIUM. Pham Tu Manh; Naoulo, Mohamed (Paris Univ., Orsay, France). Compt. Rend., Ser. B; 273: No. 12, 446-9(20 Sep 1971). (In French).

High gains can be obtained with a parametric amplifier using a plasma–beam system, when the frequency of the pumping wave is lower than that of the signal. Only an interaction in which a harmonic of the pumping wave intervenes can explain the result. (France)

8397 EFFECT OF THE SPECTROMETER ON THE BROADENING OF THE EMISSION LINE PROFILE OF AN ARGON PLASMA. Queffelec, J. L. (Rennes Univ., France); Girault, M.; Louer, Daniel. Compt. Rend., Ser. B; 273: No. 15, 649-52(11 Oct 1971). (In French).

The LWL unfolding method was used to study the effect of the spectrometer itself on the broadening of argon emission lines in an argon–hydrogen plasma whose temperature is constant in the direction of the observation. The line profiles recorded by photoelectric spectroscopy were considered as being dispersion profiles. The true emission line profiles were calculated; the correction curve which gives the half-width of the true emission line profile from the half-width of the registered profile was constructed. These calculations were applied to the 4806 Å line of Ar II and the variation of the half-width at half maximum of this line was obtained as a function of the plasma electron density. (France)

8398 EFFECT OF A WEAK TRANSVERSE MAGNETIC FIELD ON THE PLASMA PRODUCED IN A CAPACITIVE hf DISCHARGE. Catherine, Yves (Univ., Nantes, France). Compt. Rend., Ser. B; 273: No. 14, 588-91(4 Oct 1971). (In French).

The existence of resonances in the plasma of an hf capacitive discharge in a transverse magnetic field was theoretically and experimentally verified. Their dependence upon the various discharge parameters was studied. (France)

Kinetics (Experimental)

8399 (FRNC-TH-70) SHOCK TUBE FOR OPTICAL STUDIES ON AN ARGON PLASMA. Thenard, Claude (Rouen Univ. (France). Faculte des Sciences). 1970. 87p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A clean shock tube was developed for studies on the structure of shock waves. Spectroscopic measurements on plasmas were envisaged. The shock tube is described and its suitability for the measurements to be made demonstrated. The relaxation time measured corresponds to the amount of impurity in the argon used. The values of the parameters deduced from the optical measurements agree with those of Grier. The preliminary results obtained demonstrate that absolute intensities of the lines and background continuum were measured to a high degree of accuracy. Curves relating to the evolution in the electronic density confirm the analytic expressions given by Petschek for the relaxation and cooling zones near to the equilibrium. (France)

8400 (FRNC-TH-75) ELECTRIC CONDUCTIVITY PERPENDICULAR TO A MAGNETIC FIELD IN AIR AND NITROGEN PLASMAS IONIZED BY A SHOCK WAVE. Cottereau, Marie-Joseph (Rouen Univ. (France). Faculte des Sciences). 1970. 144p. (In French). Dep. NTIS (U. S. Sales Only).
Thesis.

Different calculational methods for determining the conductivity tensor of an ionized gas were analyzed. Particular attention was given to the experimental results of Lin et al. concerning shock-wave ionized plasmas. A shock tube was used to obtain air or nitrogen plasmas and a four-electrode device was developed for making the measurements. The Joule effect in a molecular gas was studied. Measurements of the electric conductivity perpendicular to a magnetic field are a good way for determining the electron collision frequency. (France)

8401 VACUUM ULTRAVIOLET SPECTRA OF A FREE PLASMA COLUMN IN AN UHF FIELD AT HIGH PRESSURE. Diatroptov, D. B.; Peskov, V. D. (Inst. of Physical Problems, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 3, 1038-46(Sep 1971). (In Russian).

The spectra of a free plasma column in a uhf field and at high pressure were analyzed in the 1000- to 4000-Å spectral range. A continuous background was observed between 1230 and 1400 Å in a helium–deuterium plasma. The Balmer line intensity was proportional to the deuterium concentration in the mixed plasma experiments, whereas the intensity of the 1215-Å line wings was independent of deuterium concentration. The experimental data so far obtained are not sufficient for a unique interpretation of the results. (auth)

8402 INVESTIGATION OF THE SPECTRUM OF THE PROPER ELECTROMAGNETIC RADIATION IN A PLASMA–BEAM SYSTEM. Zakatov, L. P.; Kingsep, A. S.; Plakhov, A. G.; Ryutov, V. D. Zh. Eksp. Teor. Fiz.; 61: No. 3, 1009-15(Sep 1971). (In Russian).

The frequency spectrum of the electromagnetic radiation from a plasma interacting with an electron beam is analyzed. A novel spectral analyzer is proposed, based on transmission of the electromagnetic signal through a solid-body layer. A broad spectrum of the radiation from the plasma is observed in the characteristic frequency range ω_{pe} to $2\omega_{pe}$. The energy density of the Langmuir noise in a plasma is estimated on the basis of the radiation with a frequency $2\omega_{pe}$. The presence of radiation with a frequency ω_{pe} indicates that in the plasma, along with Langmuir radiation, low-frequency oscillations are also produced. (auth)

8403 ENHANCED SCATTERING OF LASER LIGHT BY OPTICAL MIXING IN A PLASMA. Stansfield, Barry Lionel. Vancouver, B. C.; Univ. of British Columbia (1971). National Library of Canada, Ottawa.
Thesis.

The enhancement of the scattered light signal due to the mixing of two optical beams in a plasma was observed. The two beams are produced in a dual-cavity organic dye laser pumped by a Q-switched ruby laser. The plasma is generated by a helium plasma jet. In normal scattering a distinct satellite is observed on either side of the incident ruby wavelength 6943 Å. The presence of enhanced oscillations is demonstrated by a significant increase in the intensity of one of these satellites when the dye lasers are tuned such that the difference in their frequencies is equal to the normally observed resonant frequency of the plasma. (Diss. Abstr. Int., B)

8404 LASER-INDUCED PERTURBATION IN A PLASMA. Baldis, Hector Alberto. Vancouver, B. C.; Univ. of British Columbia (1971). National Library of Canada, Ottawa.
Thesis.

The interaction between a 20-MW Q-switched ruby laser pulse and a partially ionized argon plasma was studied experimentally. When the focused laser pulse is fired into the plasma, a transient emission from the plasma may be observed both in the continuum and line emission. From measurements of the absolute intensities of this transient radiation, estimates were made of the population density of the excited atoms and of the electron densities. The Stark broadening of the Ar II lines was also measured to obtain the electron density in the transient plasma, and data obtained in this way are consistent with those obtained from the continuum radiation. During the time when the laser light is incident on the plasma, the Ar II lines show a strong asymmetry which disappears quickly after the laser pulse has terminated. This asymmetry can be explained in terms of the electron-density gradient present in the expanding perturbed plasma. (Diss. Abstr., Int., B)

8405 DYNAMICS OF THE INVERSE PINCH. Weisbach, Michael Frederick. Seattle; Univ. of Washington (1971). 91p. University Microfilms Order No. 71-28,491.
Thesis.

High-quality measurements were made on the plasma produced in a large inverse pinch using argon with no applied magnetic fields or pre-heating. For a wide range of conditions, very accurate simultaneous data were obtained for the electron density, electron temperature, and electromagnetic fields throughout the current sheet. These data were then used to obtain profiles of the plasma velocity, electric conductivity, and ion density. A direct observation was made of the precursor ionization, which initially raises the electron temperature and electrical conductivity. Both of these parameters were found to remain nearly constant throughout the current sheet ($T_e \sim 2.5$ eV, $\sigma \sim 8 \times 10^3$ mho/m). Calculations show that most of the mass is entrained in the current sheet, but that less than complete sweeping occurs at the lower velocities. The shock imbedded in the current sheet closely resembles an ordinary gasdynamic shock. Consideration of the shock jump condition derived from the induction equation is shown to determine the inability of the shock to separate from the current sheet when σ is approximately constant. The shock can move ahead of the current density peak only if a mechanism exists for a rapid increase in σ while the current density is increasing. (Diss. Abstr. Int., B)

8406 SPECTRAL LINES OF A HELIUM PLASMA IN A POST-LUMINESCENCE θ PINCH. Beschaposhnikov, A. A.; Kuchuberiya, I. Kh.; Razmadze, N. A.; Simonova, N. V. Zh. Prikl. Spektrosk.; 15: No. 2, 328-30(Aug 1971). (In Russian).

A record of spectral lines being emitted by a decaying dense plasma can yield information on the change in concentration and temperature of electrons during the decay process. Plasma of a θ pinch was investigated by discharging 5-μF capacitors at 35 kV through an eight-cm diameter chamber in 3.5 μsec. The chamber contained He at 0.1-mm Hg pressure. The auxiliary equipment included a monochromator, a photoelectron multiplier, and an oscillograph. During the post-luminescent intervals at 45, 70, and 100 μsec, electron concentrations of 6×10^{16}, 3.2×10^{16}, and 8×10^{15} cm^{-3}, and temperatures of 3.4, 3.1, and 2.9 eV, respectively, were recorded. (K.S.W.)

8407 CHARACTERISTICS OF TURBULENCE IN A REFLEX-ARC PLASMA. Hooper, E. B. Jr.; Girvin, Steven M. (Yale Univ., New Haven). J. Appl. Phys.; 42: No. 12, 4832-40 (Nov 1971).

The spectral characteristics of turbulence in a reflex arc with thermionic cathodes are described. There are two regimes of qualitatively different behavior: (i) As the magnetic field is increased above the range for which the oscillations are coherent ($\lesssim$250 G) an m = 1 and m = 2 mode coexist with several beat frequencies. (ii) At higher fields ($\gtrsim$750 G) two frequencies (related by a factor of 2) are observed; different correlation times are associated with each. Present models of plasma turbulence are inadequate to describe the observations. (auth)

Kinetics (Theroretical)

Refer also to abstracts 7624 and 8425.

8408 (KHFTI-70-32) STRUCTURE OF THE SPACE CHARGE FIELD OF A CHARGED PARTICLE BUNCH. Lysenko, O. E.; Khizhnyak, N. A. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1970. 13p. (In Russian). Dep. NTIS (U. S. Sales Only).

The solution of the equations of motion of accelerated particles, allowing for the influence of the force of space charge, requires information on the structure of the internal field for various configurations of the accelerated cluster and different particle distributions in space. The space charge field of an ellipsoidal plasma cluster was investigated for the case when the density of the charge varied in accordance with a power law. The space potentials of an ellipsoid of revolution were calculated for linear, quadratic, and cubic distributions of the charge density. (tr-auth)

8409 EFFECT OF INITIAL CORRELATION ON THE KINETIC EQUATION. Lee, Donald Travers. Buffalo; State Univ. of New York (1971). 82p. University Microfilms Order No. 71-22,574. Thesis.

In the bulk limit: N(particle number) $\to \infty$, Ω(volume) $\to \infty$, such that N/Ω = constant, the one-body density operator n(t), describing interacting distinguishable particles, satisfies a closed evolution equation. This equation contains a set of terms that explicitly depends on the initial correlation operators χ in contrast to a typical kinetic equation such as Boltzmann's equation. The nature of these terms is investigated. It is explicitly shown that the initial pair correlation ceases to influence the evolution of n(t) after a time of the duration of collision for a weakly coupled low-density gas. (Diss. Abstr. Int., B)

8410 UNIQUENESS AND RECIPROCITY THEOREMS IN THE HOT PLASMA THEORY. Fabrizio, Mauro. Boll. Unione Mat. Ital.; 2: 542-53(Aug-Oct 1969). (In Italian).

The possibility of extending Wheeler and Sternberg's (1968) uniqueness and reciprocity theorems in an elastic medium occupying an infinite domain is discussed. The extension considered is to questions regarding the propagation of electromagnetic waves in a plasma, provided that the equations governing these phenomena are suitably linearized. (IAA)

8411 USE OF COMPUTERS IN PLASMA PHYSICS RESEARCH. Zhdanov, A. I.; Klimko, N. P.; Dem'yanov, V. G. Vestn. Khar'kov. Politekh. Inst.; No. 50, 57-63(1970). (In Russian).

Analog computers have been used in model simulation for plasma physics studies. Block circuitry is diagrammed and discussed for a small analog complex, which was used to gather data and investigate models which described systems of nonlinear ordinary differential equations up to the 15th order, both with single and iterative solutions. The maximum time for a solution was 200 sec, with a relative error of $\leq$10%. (K.S.W.)

8412 RETURN CURRENT INDUCED BY A RELATIVISTIC ELECTRON BEAM PROPAGATING IN A MAGNETIZED PLASMA. Lee, Roswell Edward Jr. Ithaca, N. Y.; Cornell Univ. (1971). 117p. University Microfilms Order No. 71-29,257.

Thesis.

The plasma current induced when a high-current relativistic electron beam is injected into a fully ionized, magnetized plasma is calculated by extending a model developed by Hammer and Rostoker to the case of injection into a magnetized plasma. In this model, a cylindrical relativistic beam of uniform density is "switched on" at t = 0 in the presence of a fully ionized plasma. The fields generated by this beam are computed as if the test particles composing the beam are unperturbed from their zero-order motion. The response of the plasma to the beam is calculated by means of a plasma conductivity tensor, which is developed in the conventional manner from Maxwell's equations, and the cold-plasma fluid equations. The current induced in the plasma by the time-changing fields associated with the head of the beam is computed as a function of the beam and plasma parameters. (TSS) (Diss. Abstr. Int., B)

8413 NONLINEAR THEORY OF STOCHASTIC ACCELERATION OF IONS BY ELECTRON BEAMS. Krasovitskii, V. B. (VNII Electrical Equipment, Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 7, 1191-3(Jul 1971). (In Russian).

The possibility of ion acceleration by a relativistic electron beam is considered. Ions may be accelerated to energies of the order of the energy of the electron beam if the ions are subjected to the influence of an electric field, generated by the electron beam in an ion plasma, and representing a set of running waves with various phase velocities. (tr-auth)

Production

8414 EXPANSION AND DIFFUSION OF A LASER PLASMA IN A MAGNETIC FIELD. Dolgov-Savel'ev, G. G.; Karnyushin, V. N. (Inst. of Nuclear Physics, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz.; 61: No. 3, 1002-8(Sep 1971). (In Russian).

Results are presented of an experimental investigation of a plasma produced by irradiation with Nd^{3+} laser pulses of separate LiH particles injected into the focus region. The expansion rate of the plasma boundary and the total amount of ions produced were measured. Data were obtained regarding the displacement of the magnetic field at the initial stage. For studying the nature of plasma disintegration in mirror and opposite magnetic fields, the technique of uhf radiation cutoff was employed. (auth)

8415 ASSEMBLY FOR PRODUCTION OF A FREE PLASMA COLUMN. DETERMINATION OF THE COLUMN CURRENT AND RESISTANCE. Kapitsa, P. L.; Filimonov, S. I. (Physical Laboratory, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 3, 1016-37(Sep 1971). (In Russian).

An assembly for production of a column hf plasma discharge freely suspended in a cavity is described. The power supply system is described. It consists of a "Nigotron" 175-kW continuous power generator that produces type H_{01} hf oscillations of wavelength 19.4 cm. The design of the device for converting the oscillations to the E_{01} type is described. The converter is of the spider type; coupling between the generator and discharge cavity can be varied by rotating the legs. The waveguide system for supplying hf power is described, and the design of the cavity in which the column is formed is presented. The equipment used for gas circulation, cooling, and discharge initiation is described. The technique employed for studying some of the physical properties of the column discharge is described. Methods for determination of power absorption in the discharge and measurement of its length and hf current in the column are presented. Experiments are described in determination of the absolute value of the hf electric field in the cavity, and it is shown that the column current is determined solely by the reactance of the column, which in turn mainly depends on the column length. Results of current measurements in a discharge in deuterium are presented for absorbed powers up to 10 kW and a column length close to the half-length of the hf field wave. The current may be as high as 75 A. The active resistance of the column is determined and the magnitude of the skin resistance is estimated. It is shown that, when the ohmic resistance of the column is due to coulomb scattering, the resistance corresponds to that of a hot plasma with an electron temperature of about a million degrees. It is also shown that, for large currents in the plasma column, a pinch may arise that can be balanced only by the plasma pressure in the hot state. (auth)

8416 SYSTEM FOR PRE-IONIZATION OF GAS IN CLOSED MAGNETIC TRAPS. Longinov, A. V.; Pitvinov, A. P.; Kitaevskii, L. Kh.; Nizhnik, G. Ya.; Frolov, V. A. Vestn. Khar'kov. Politekh. Inst.; No. 50, 76-9(1970). (In Russian).

A system is described for the preliminary ionization of gas in stellarators, and includes a pulsed high-frequency generator, a modulator, and electronic control. The basic circuitry shows a vacuum chamber with a ceramic (dielectric) insert as part of the collector unit. An electric field is established either by means of a metallic portion of the vacuum chamber or by a supplementary coil arranged near the chamber. A simplified diagram of the modulator is presented. Sample oscillograms illustrate the effect of varying shunting resistance in the generator and impulses at various locations in the modulator, respectively. (K.S.W.)

8417 PRODUCTION OF FUSION PLASMAS WITH LASERS. Witkowski, Siegbert (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Elektrotech. Z., A; 92: No. 5, 273-7(1971). (In German).

Irradiation of solids with high-power pulsed lasers produces plasmas of high density and high temperature. After an assessment of minimum energies necessary to obtain energy release, two models are described for plasma production by lasers. Some of the most important experimental results in this field are reviewed. (tr-auth)

8418 CONTINUOUS CONFINEMENT OF PLASMA BY A LASER BEAM AND AN OPTICAL PLASMATRON. Raizer, Yu. P. Vestn. Akad. Nauk SSSR; No. 10, 28-32(Oct 1971). (In Russian).

The various basic techniques for creating plasmas are briefly reviewed, each possessing its own virtues and deficiencies. With the novel laser approach, the laser is permitted to "fire" in air with a 1-mm-diameter ray with about 4 kW of power. This quantity of power is necessary but still possible for the focused light beam. Plasma will "burn" in the field of focus, where the burning remains stable; the discharge cannot migrate far from the focus. According to calculations, and given good focusing, a statistical discharge may "burn" in air at a power of 2 kW. Only a few hundreds of watts will suffice for heavy, monatomic gases such as Xe or Ar at elevated pressures. Experiments that support this picture are described. (K.S.W.)

Stability

8419 PROBLEM OF GRAVITATIONAL INSTABILITY OF A PLASMA IN THE PRESENCE OF THE HALL EFFECT. Mattei, Giulio. Boll. Unione Mat. Ital.; 3: 230-41(Apr 1970). (In Italian).

The gravitational instability of a compressible plasma considered as a continuous medium is discussed. The condition for instability is determined relative to a class of axisymmetric perturbations. The influence of a uniform rotation and finite electrical conductivity are taken into account. (IAA)

8420 RELATION BETWEEN THE OSCILLATION AND THE PERPENDICULAR DIFFUSION IN A FIELD-FREE MAGNETOPLASMA. Kando, Masashi; Takeda, Susumu (Nagoya Univ., Japan). Jap. J. Appl. Phys.; 10: No. 12, 1720-3(Dec 1971).

The perpendicular diffusion coefficient $D_\perp$ is calculated from the measured radial density gradient in a weakly ionized helium plasma with no applied electric field at a pressure of 2.0 mtorr. The measured $D_\perp$ is inversely proportional to the square of the magnetic field B, when the oscillation in the plasma is small. However, $D_\perp$ increases with B, when the oscillation rapidly increases. The same phase of the oscillation is observed at any point in the tube. (auth)

8421 LOW-FREQUENCY INSTABILITY IN A PLASMA PRODUCED BY A LOCAL ELECTRON CYCLOTRON RESONANCE. Abe, Haruhiko (Kyoto Univ.). J. Phys. Soc. Jap.; 31: No. 6, 1809-19(Dec 1971).

A low-frequency oscillation, having a backward wave-type dispersion relation, is spontaneously excited in a plasma produced by local electron cyclotron resonance. The fundamental frequency of the oscillation is smaller than ion cyclotron frequency and is nearly inversely proportional to the magnetic field intensity. Radially, the wave amplitude has maxima near the regions of maximum density gradient. The wave is observed to propagate in the direction of the ion diamagnetic velocity. The phase angle between density and potential wave is about 90° and density wave is leading. These characteristics of the oscillation are compared with those of the collisional drift wave. Further, a nonlinear effect characterized by the self-excitation of the subharmonic oscillations of $1/2$, $1/3$, $1/4$, and their higher harmonics is also observed. (auth)

8422 HOLE EQUILIBRIA IN A QUASI-COLD PLASMA. Kako, Masashi; Taniuti, Tosiya; Watanabe, Tsuguhiro (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 31: No. 6, 1820-9(Dec 1971).

A theoretical investigation was made of hole equilibria in phase space, such as being observed in numerical experiments on the two-stream instability of counterstreaming, equal, electron beams in a background of fixed ions. It is assumed that the thermal velocity of the plasma surrounding holes in phase space is sufficiently small. The equilibria are classified into two groups: quasi-cold hole equilibria and dressed hole equilibria. The former equilibria are characterized by the smallness of the shielding distance, i.e., the distance between adjacent holes required to shield the charge of holes; in the latter, adjacent holes are separated by long shielding distance even for sufficiently small thermal velocity. (auth)

8423 COLLISIONAL DRIFT INSTABILITY DRIVEN BY AN AXIAL CURRENT. Ellis, R. F.; Motley, R. W. (Princeton Univ., N. J.). Contract AT(30-1)-1238. Phys. Rev. Lett.; 27: No. 22, 1496-9(29 Nov 1971).

The current-driven collisional drift instability is observed in a double-ended Q-machine cesium plasma. The instability is of large amplitude and leads to significant density decrease at onset. The characteristics of the instability are in good agreement with a linearized two-fluid theory which includes electron heat flow and electron temperature oscillations. (auth)

8424 FLUTE STABILIZATION VIA ELECTROSTATICALLY CONFINED COLD ELECTRONS. Guest, G. E. (Oak Ridge National Lab., Tenn.); Harris, E. G. Phys. Rev. Lett.; 27: No. 22, 1500-3(29 Nov 1971).

Flute instabilities driven by unfavorable magnetic field curvature can be stabilized by a positive ambipolar potential, which confines cold electrons electrostatically. This mechanism does not depend on line-tying in the conventional sense. Stability criteria are derived, and their relation to experimental observations is discussed. (auth)

8425 COMPUTER SIMULATION OF ANOMALOUS dc RESISTIVITY. Biskamp, D.; Chodura, R. (Max Planck Inst. fuer Plasmaphysik, Garching, Ger.). Phys. Rev. Lett.; 27: No. 23, 1553-6(6 Dec 1971).

The current-driven ion-sound instability is investigated by two-dimensional computer experiments. It is found that, in contrast to the one-dimensional case, the instability produces an anomalous resistivity. (auth)

8426 THETAPINCH EXPERIMENTS WITH TRAPPED ANTIPARALLEL MAGNETIC FIELDS. Eberhagen, A.; Grossmann, W. (Max-Planck Institut fuer Plasmaphysik, Garching, Ger.). Z. Phys.; 248: No. 2, 130-49(1971).

Experimental evidence presented shows that stability for a cylindrical plasma sheet confined by antiparallel magnetic fields is established for times longer than theoretically predicted growth times for tearing instabilities by at least an order of magnitude. It is shown that the enhanced stability is not due to wall effects, inertia effects, too short a pinching coil, finite Larmor radius, and viscosity effects. One possible explanation for the stability is shown to be related to the level of initial plasma perturbation. Further, the enhanced stability can be explained by the observed plasma rotation. It is shown by simple arguments that the rotation can cancel the tearing mode's growth and that the rotation itself is a result of the diffusion of angular momentum across the neutral surface enclosing the confined plasma. (auth)

Thermonuclear Processes

8427 (DLR-FB-67-59) HIGH-TEMPERATURE ENERGY SYSTEMS WITH PLASMA REACTORS AND INDUCTIVE MAGNETOPLASMADYNAMIC CONVERTERS. Peschka, W. (Deutsche Versuchsanstalt fuer Luft- und Raumfahrt E. V., Stuttgart (West Germany). Institut fuer Energiewandlung und Elektrische Antriebe). Aug 1967. 25p. (In German). Dep. NTIS (U. S. Sales Only).

Possible future power-generating equipment that operates with high-temperature plasma as a working medium and subsequently with high power density is investigated. This temperature range requires reactors whose nuclear fuel is in the plasma state (fission or fusion reactors) coupled to magnetoplasmadynamic generators acting as energy converters. Electrodeless MPD generators with all their advantages can be successfully employed. The technological ramifications arising from the application of these high temperatures with respect to the reactors and the MPD generators as well as to the heat-release equipment are discussed. (auth)

8428 (UCRL-51104) COMPUTATIONAL STUDY OF MAGNETIC SURFACES IN THE MINIMUM-AVERAGE-B LEVITRON WITH NONAXISYMMETRIC PERTURBATIONS. Freis, R.; Hartman, C.; Killeen, J. (California Univ., Livermore. Lawrence Radiation Lab.). 2 Aug 1971. Contract W-7405-eng-48. 23p. Dep. NTIS.

A computational study is presented of the effect of floating-ring tilt on magnetic surfaces in the levitron. An unperturbed field configuration is considered which is formed by the ring field, a toroidal field, and a vertical field adjusted to form a separatrix with the stagnation point at $r/R_{\text{ring}} = 0.25$. Magnetic surfaces are destroyed by ring tilt $\delta \approx 0.1°$ in the region between the separatrix $(i = 0)$ and the surface for which $i = 2\pi$. Resonant surfaces closer to the ring form regular islands where $i/2\pi = (n + 1)/2$, $n = 1$ to 5, while nearer the ring where $n > 5$ essentially no perturbing effect is observed. Islands for $n = 0, 1$ increase in width as $\delta^{1/2}$ until breakup into ergodic lines occurs by means of secondary island formation. For $n = 2$ to 5, the island width increases as $\approx\delta^{1/4}$ in contrast with the predicted $\delta^{1/2}$ dependence. The dominant perturbing field is the component directed along the symmetry axis. (auth)

8429 ECONOMICS OF A HYPOTHETICAL ^{3}He–D FUSION REACTOR FOR CENTRAL STATION POWER. Hilton, John L. (Aerojet-General Corp., San Ramon, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 4, 20-8(Aug 1969).

Physical fundamentals and approximate parameters for controlled energy release by thermonuclear fusion are reviewed. Assuming present research will successfully develop a fusion reactor, a comparison is made between different possible fusion power cycles. An approximate electrical power cost breakdown from the D–T and ^{3}He–D systems (including the needed fuel breeding cycles) is calculated. (auth)

8430 PROMISE OF CONTROLLED FUSION. Mills, Robert G. (Princeton Univ., N. J.). IEEE (Inst. Elec. Electron. Eng.), Spectrum; 8: No. 11, 24-36(Nov 1971).

One of the outstanding reasons for the active development of controlled fusion nuclear reactors as a source of electric power, aside from economic advantages, is that they are extremely attractive from an environmental standpoint. The basic principles and some of the most pressing problems are presented. Among the problems considered are plasma confinement, heating, fuel injection, and exhaust collection. (auth)

8431 OUTLOOK FOR CONTROLLED FUSION POWER. Tuck, J. L. (Los Alamos Scientific Lab., N. Mex.). Nucl. Eng. Int.; 16: No. 186, 924-30(Nov 1971).

The advantages and disadvantages of fission and fusion reactors are compared. A summary of the general requirements of fusion reactors is followed by more detailed consideration of the special characteristics and problems involved in the development of four possible types, i.e., Tomamak reactors, the direct-conversion mirror fusion reactor, the Scylla linear θ-pinch reactor, and a conceptual laser DT pellet reactor. It is estimated that fusion reactors will be competitive by the year 2000. The effect of this development on helium production and consumption is examined. (UK)

8432 MAGNETIC CONFIGURATION OF THE TOROIDAL VINTOTRON. Aleksin, V. F.; Nemov, V. V.; Shishkin, A. A. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 7, 1126-33(Jul 1971). (In Russian).

The magnetic configuration of the toroidal "vintotron" was investigated. The magnetic system of the vintotron is created by a large longitudinal field, field of an axial current and one-, two-, three-turn helical magnetic field. This trap has a spatial magnetic axis. In the system of Mercier's coordinates connected with the helical line of the torus, the expressions for the magnetic field components are obtained; the differential equations of the magnetic force lines are solved with the exactness to the terms $\delta \ln \delta^{-1}$ and δ, where $\delta = a/R \ll 1$ (a and R are small and large radii of the torus). The magnetic force lines are shown to create the closed magnetic surfaces near the magnetic axis and the position of the toroidal vintotron magnetic axis from the straight vintotron magnetic axis is estimated. (auth)

8433 ANALYSIS OF THE TOROIDAL MAGNETIC FIELD IN THE HELIOTRON C DEVICE. Oshiyama, Hiroshi (Kyoto Univ.). Mem. Fac. Eng., Kyoto Univ.; 33: No. 3, 151-62(Jul 1971).

An analysis of the magnetic field produced by a current flowing in the Heliotron C coils is carried out. Under the assumption that the coil radius is much smaller than that of the torus, the calculation resorts to the perturbation method in which all quantities are expanded in κa, where κ is the torus curvature and a the radius of coil. The Heliotron C magnetic field is obtained analytically as a function of coil radius, the current ratio of adjacent coils, the distance of adjacent coils, and the curvature of the torus. The accuracy of this magnetic field is examined. (auth) (Japan)

8434 OUTLOOK FOR CONTROLLED FUSION POWER. Tuck, J. L. (Los Alamos Scientific Lab., N. Mex.). Nature (London); 233: No. 5322, 593-8(29 Oct 1971).

Fission and fusion are compared as sources of energy for the future. Energy reserves for the two are considered to be similar, as are their pollution and ecological characteristics. A remote integrated site policy is recommended for fission. (auth)

Wave Phenomena

8435 THREE WEAKLY COUPLED OSCILLATORS AS A MODEL FOR RESONANT MODE INTERACTION IN A MILDLY INHOMOGENEOUS PLASMA. Maroli, C. (CNR, Milan. Univ., Milan). Lett. Nuovo Cim.; 2: No. 17, 904-8(23 Oct 1971).

The equation $(d^2/dt^2)x_j(t) + \omega_j^2 x_j = -\epsilon x_h x_k$, where $0 < \epsilon \ll 1$, can be assumed as a satisfactory model for the nearly linear, resonant interaction between three modes in a homogeneous plasma. An analysis of this system for different conditions is presented. (M.O.W.)

8436 PENETRATION OF ELECTROMAGNETIC WAVES INTO A PLASMA WITH ALLOWANCE FOR NONLINEARITY. Liberman, M. A.; Rakhimov, A. T. (Inst. of Physical Problems, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 3, 1047-56(Sep 1971). (In Russian).

The structure of an electromagnetic field in a weakly ionized plasma is obtained under conditions when the electromagnetic wave affects the ionization balance. Incidence of an electromagnetic wave with a frequency greater than the effective frequency of encounters between electrons and atoms and less than the plasma frequency is considered. It is shown that, when the electromagnetic wave affects the ionization balance in the plasma, the penetration depth of the wave in the plasma strongly decreases but nevertheless remains considerably greater than c/ω_p, where ω_p is the plasma frequency established at the plasma boundary under the influence of the electromagnetic wave. (auth)

8437 PARAMETRIC EXCITATION OF OSCILLATIONS IN A PLASMA BY THE FIELD OF A MODULATED UHF WAVE. Aliev, Yu. M.; Zyunder, D. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 3, 1057-64(Sep 1971). (In Russian).

It is well known that the proper oscillation spectrum of a plasma located in the field of a monochromatic wave depends on the amplitude of the applied uhf field. It is shown that by employing amplitude modulation of an external uhf field, for which the plasma is transparent, oscillations can be excited whose frequency spectrum is determined by the field strength for the carrier frequency. Cases of weak and strong modulation are considered. The frequencies and field strengths are found for which either high-frequency, low-frequency, or coupled-potential high- and low-frequency oscillations are excited. Since the carrier frequency of the modulated field exceeds the Langmuir frequency, the field can easily penetrate deeply into the plasma. Consequently, modulated uhf signals can be employed for volume heating and plasma diagnostics. (auth)

8438 WAVE CONVERSION AND RESONANCE BELOW SECOND ELECTRON CYCLOTRON HARMONIC: OBLIQUE INCIDENCE. Peratt, Anthony Lee. Los Angeles; Univ. of Southern California (1971). 211p. University Microfilms Order No. 71-27,945.

Thesis.

Equations describing the effect of wave coupling on the electric fields in an inhomogeneous magnetized plasma are derived and solved for the case of an obliquely incident transverse electromagnetic wave whose frequency is near and below the second electron cyclotron harmonic. The plane of incidence is taken to be perpendicular to the static magnetic field so that Landau or cyclotron damping is not present. The efficiency with which the power of the transverse wave is converted to that carried in the longitudinal plasma wave is determined by considering a plasma half-space whose density increases monotonically from zero to some constant value and which, at some point, satisfies the hybrid resonance condition. The mode coupling is found to be inversely proportional to the density gradient at the hybrid resonance and occurs near this point. The theory, based on the Pearson equations with electron collisions included, shows that the impedance of a thin plasma slab exhibits a resonant structure due to longitudinal waves confined between the two hybrid resonance points. Analytical expressions for the reflection and transmission coefficients and electric fields within the plasma slab are derived and compared to solutions obtained by numerical integration. Measurements are performed during the afterglow of a pulsed, low-pressure, argon plasma confined between planar glass walls. The impedance measurements are found to be in good agreement with the theoretical model. (Diss. Abstr. Int., B)

8439 NONLINEARITIES IN PLASMA: THEORETICAL INVESTIGATION OF HARMONIC GENERATION IN STRATIFIED GEOMETRY. Georges, George C. New York; New York Univ. (1971). 231p. University Microfilms Order No. 71-29,672.

Thesis.

The one-component, isotropic, nonlinear fluid-model plasma equations are analyzed using a guided-wave modal representation. All nonlinearities that are bi-quadratic in the field variables are included. This treatment expresses the original nonlinear fields problem as a coupled system of nonlinear ordinary differential equations for the modal coefficients of the representation. Explicit modal equations are presented by deriving detailed formulas for the coupling coefficients in the nonlinear interaction processes. This description is used to study the development along say the $\underline{z}_0$ spatial direction of a wave-train solution which is assumed to emanate as a sinusoid at Z = O. Also a study is made of the response of a plasma slab due to an incident electromagnetic plane-wave excitation. Detailed plots are given of the internal modal amplitudes for the fundamental modes and it is shown that they attain peak values when the slab is excited at its Tonks–Dattner resonance points. By plotting resonance curves for the second and third harmonic components, it is shown that the Tonks–Dattner resonance points also produce greatest nonlinear harmonic generation. (TSS) (Diss. Abstr. Int., B)

8440 STUDY OF THE TONKS–DATTNER RESONANCES IN AN AXIAL MAGNETIC FIELD. Willis, John Wayne. Riverside, Calif.; Univ. of California (1971). 126p. University Microfilms Order No. 71-30,389.

Thesis.

An experimental investigation of the effect of a uniform axial magnetic field upon the Tonks–Dattner resonance spectrum was carried out. The experiments were performed on the positive column of a low-pressure mercury discharge tube for frequencies ranging from 450 to 920 MHz. The resonances are excited in the normal fashion using a split-cylinder capacitor, and additionally, by means of a polarized signal devised to preferentially excite one or the other of the two angular modes, $\exp(\pm \iota \theta)$. The results of this investigation are in good agreement with Parker's analysis for fields as high as 40 G($\omega/\omega_c > 3$, where ω_c is the electron cyclotron frequency). The splitting is found to be approximately constant for low fields over the density range investigated ($100 < r_w^2/\overline{\lambda_D^2} < 2500$, where r_w is the radius of the plasma tube and $\overline{\lambda_D^2}$ the radially averaged square of the Debye length); for the main resonance $\Delta\omega \approx 0.9\omega_c$, for the first resonance $\Delta\omega \approx 0.5\omega_c$, and for the second resonance $\Delta\omega \approx 0.35\omega_c$. Additionally, it is found that a right or left circularly polarized signal can be used to excite one or the other of the split peaks independently. At higher values of the magnetic field (90 G, ω/ω_c as low as 1.7) the shifts in resonance frequency at the cyclotron harmonics noted by Schmitt et al., are observed, though the effect is different for the two separate peaks. The resonance spectrum is further complicated by the appearance of Buchsbaum–Hasegawa modes at frequencies between the split Tonks–Dattner resonances. In this high field regime the two forms of plasma column resonance appear to be more closely connected than previously suspected. Application of the polarized excitation shows the Buchsbaum–Hasegawa modes found here to be strongly coupled to a right circular polarized signal. (TSS) (Diss. Abstr. Int., B)

8441 SCATTERING OF A STRONG ELECTROMAGNETIC WAVE BY AN ELECTRON IN A MAGNETIC FIELD. Zel'dovich, Ya. B.; Illarionov, A. F. (Inst. of Applied Mathematics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 3, 880-5(Sep 1971). (In Russian).

Scattering of a strong electromagnetic wave ($E > mc\omega/e$) by an electron in a plasma is considered. The circular polarized wave propagates along a static magnetic field. Radiation reaction is taken into account. The dependence of the scattering cross section on wave amplitude and magnetic field strength is found. The conditions for propagation of the wave in a plasma are deduced. (auth)

8442 IONIZATION WAVES AND WAKES EXCITED BY AN ACOUSTIC PULSE. Krejci, V. (Inst. of Physics, Prague). Czech. J. Phys.; 21: No. 8, 828-35(1971).

Any sudden change of plasma parameters in an originally homogeneous positive column of a low-current discharge usually gives rise to a transient process called waves of stratification. Another form of ionization waves, a periodic wake, may be noticed in the neighborhood of a permanent local disturbance of plasma homogeneity. In this work a third form of ionization wave, which accompanies a pulse propagating with constant velocity through the plasma, is described. After a short description of the experimental techniques, a phenomenological theory of the phenomena observed in the resulting diagrams is given. (auth)

8443 ELECTRON-CYCLOTRON WAVE RESONANCE IN INDUCTIVELY COUPLED hf DISCHARGES. Szuszczewicz, Edward P. (Univ., Wuerzburg, Ger.). J. Appl. Phys.; 42: No. 12, 4794-8(Nov 1971).

The theory of Pfeiffer on electron-cyclotron wave resonance phenomenon in inductively coupled hf ring discharges has been extended by Sager to include electron temperature, nonuniform density distributions, and the finite dimensions of a plasma of rectangular cross section. A scheme is herein proposed for adapting Sager's results to the experimentally important case of circular cross section. In order to test the scheme, an experiment was conducted in a low-pressure hf (27 MHz) argon discharge of cylindrical geometry with plasma densities in the range (1.0 to $3.5) \times 10^{11}/\text{cm}^3$ and static magnetic fields less than 60 G. The agreement between theory and experiment is found to be good and lends credence to the scheme as a means for predicting resonance values of the magnetic field in cylindrical hf discharges. (auth)

8444 SCATTERING OF ELECTROMAGNETIC WAVES BY SPACE–TIME FLUCTUATIONS IN THE ELECTRON DENSITY OF A PLASMA. Bertrand, Pierre (ONERA, Chatillon, France). Compt. Rend., Ser. B; 273: No. 16, 718-20(18 Oct 1971). (In French).

The propagation of waves in a nonstatic random medium is studied, using the method of geometrical optics. (France)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstract 6739.

8445 (CONF-710935-5) APPLICATIONS OF OPERATOR AID COMPUTERS IN NUCLEAR POWER PLANTS. Paper No. 71 TP 707-PWR. Reeves, Henry L. Jr. (Duke Power Co., Charlotte, N. C.). 24 May 1971. 6p. IEEE, New York $1.35.

From Joint power generation conference; St. Louis, Mo. (19 Sep 1971).

Duke Power Company installs a plant computer for each new generating unit which is called an Operator Aid Computer. Application at Oconee Nuclear Station, which is Duke's first commercial nuclear station has required new functions. The differences in the application at Oconee and future nuclear stations are compared to the functions required at previous fossil-fired stations. (auth)

8446 (DOCKET-1155-143) LA CROSSE BOILING WATER REACTOR. Fuel Assembly No. 69. (Dairyland Power Cooperative, La Crosse, Wis.). 7 Dec 1971. 19p. Dep. NTIS.

Stress analysis for the incomplete fuel assembly No. 69 is presented. (D.C.C.)

8447 (DOCKET-50155-94) BIG ROCK POINT NUCLEAR PLANT. Technical Specifications, Proposed Change No. 27. (Consumers Power Co., Jackson, Mich.). 9 Dec 1971. 14p. Dep. NTIS.

Revised technical specifications are presented concerning the design characteristics of Type J2 PuO_2-UO_2 bundle-arranged rod-type fuel elements. (D.C.C.)

8448 PROPOSED IEEE CRITERIA FOR CLASS IE ELECTRICAL SYSTEMS FOR NUCLEAR POWER GENERATING STATIONS. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-16: No. 4, 31-40(Aug 1969).

Criteria and requirements for the electrical systems of nuclear generating stations specifically related to providing protection to the health and safety of the public are presented. These are based on the following: redundant systems that require electric power are provided to cope with design basis events; the conditions and the availability of the various portions of the systems following a design basis event cannot be predicted exactly; and the access to certain equipment following a design basis event may be limited for several months. (auth)

8449 GROUTING TESTS ON LARGE POST-TENSIONING TENDONS FOR SECONDARY NUCLEAR CONTAINMENT STRUCTURES. Schupack, Morris (Schupack Associates, Stamford, Conn.). J. Prestressed Concrete Inst.; 16: No. 2, 85-97(Mar-Apr 1971).

Tests of sedimentation (bleeding) and expansion of neat cement grouts were made as part of a program to insure successful grouting of large-capacity, long vertical post-tensioning tendons and large-capacity tendons on sharp curvatures. Water reducing and expansion producing admixtures for grout are recommended, together with standpipes at all high points of the tendon to assure elimination of voids. (auth)

8450 FESSENHEIM NUCLEAR POWER PLANT. Mizzi, E. (Electricite de France, Clamart). Tech. Mod.; 63: No. 9, 297-300(Sep 1971). (In French).

The installations planned for the first Fessenheim unit and their siting are briefly described. The design of the nuclear boiler follows that of the PWR developed by Westinghouse, the standardized primary circuit having three coolant loops. The reactor building, which contains the nuclear boiler is provided with a spray system. Most of the nuclear facilities associated with the reactor operation and safety are situated in an adjoining building. The secondary circuit is adapted, to be used with a 2774 MW(t) boiler, a boiler power of 2660 MW(t) or more (nominal power) may thus be used. The turbogenerator unit is designed for a nominal power of 970 MW. (France)

8451 FUEL ELEMENT EXPERIENCE IN NUCLEAR POWER REACTORS. Simnad, Massoud T. AEC Monograph. New York; Gordon and Breach, Science Publishers, Inc. (1971). 630p. $19.00. (TID-25870).

The characteristics of specific reactors are summarized and the fuel element designs, materials, and operational and developmental experience are reviewed. The reactors are classified according to the types of coolants used, and selective lists of references are provided for each reactor. (H.D.R.)

8452 HEYSHAM NUCLEAR POWER STATION. McKean, J. D. (British Nuclear Design and Construction, Ltd., Whetstone, Eng.); Tyrell, J.; Lawson, D. S.; Burrow, R. E. D. Nucl. Eng. Int.; 16: No. 186, 915-23(Nov 1971).

The 1244 MW(e) station at Heysham has two AGR type reactors contained in prestressed concrete pressure vessels incorporating removable boilers. It is situated close to highly populated areas and the design includes several special safety features. The most notable are prestressed concrete closures for the pod boilers, and the incorporation of secondary and tertiary shutdown systems. Descriptions are given of these and other features including the pressure vessel, fueling system, control system, and irradiated fuel discharge facility. A colored cut-away drawing of the station and a list of parameters are presented on a large pull-out chart. (U.K.)

8453 ASEISMIC DESIGN IN THE TSURUGA NUCLEAR POWER PLANT. II. DESIGN OF REACTOR BUILDING, REACTOR CONTAINMENT, AND REACTOR PRESSURE VESSEL. Akino, Kinji; Kato, Muneaki; Tamura, Seiya (Japan Atomic Power Co., Tokyo). Nippon Genshiryoku Gakkaishi; 13: No. 2, 85-90(Feb 1971). (In Japanese).

A summary of the seismic calculations covering the main components is presented. (auth)

Operation and Economics

8454 (CONF-710935-2) SMALL COMPUTER: AN ECONOMICAL SOLUTION FOR HANDLING NUCLEAR OPERATIONAL DATA. Paper No. 71 CP 703-PWR. Blackstein, F. P. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). 30 Apr 1971. 7p. Dep. NTIS (U. S. Sales Only). IEEE, New York $1.35.

From Joint power generation conference; St. Louis, Mo. (19 Sep 1971).

The use of small-to-medium digital computers is discussed, with a view to reducing the burden of nuclear station operators in dealing with reactor data. Heretofore, large central computer installations have been charged with the bulk of this responsibility. However, experience has shown that smaller machines, carefully programmed, are of significant value to station operators. (auth)

8455 (DOCKET-1155-144) LA CROSSE BOILING WATER REACTOR. Technical Specifications, Change No. 4 Authorized. (Division of Reactor Licensing (AEC), Washington, D. C.). 13 Dec 1971. 4p. Dep. NTIS.

Revised technical specifications are presented which allow the main coolant circulation and feedwater pumps to automatically follow steam demand up to a 1.5 MW(e) per minute rate of change. (D.C.C.)

8456 (DOCKET-1155-145) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report, June 1971. (Dairyland Power Cooperative, La Crosse, Wis.). 39p. (DPC-851-29). Dep. NTIS.

8457 (DOCKET-1155-146) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report, July 1971. (Dairyland Power Cooperative, La Crosse, Wis.). Contract AT(11-1)-851. 27p. (DPC-851-32). Dep. NTIS.

8458 (DOCKET-50016-134) ENRICO FERMI ATOMIC POWER PLANT. Report for July 1971. (Power Reactor Development Co., Detroit, Mich.). 7 Dec 1971. 12p. (PRDC-EF-95). Dep. NTIS.

8459 (DOCKET-50016-135) ENRICO FERMI ATOMIC POWER PLANT. Report for August 1971. (Power Reactor Development Co., Detroit, Mich.). 14 Dec 1971. 15p. (PRDC-EF-96). Dep. NTIS.

8460 (DOCKET-50146-98) SAXTON NUCLEAR EXPERIMENTAL REACTOR PROJECT. Accidental Release of Radioactive Gases on November 29, 1971. (Saxton Nuclear Experimental Corp., Pa.). 9 Dec 1971. 2p. Dep. NTIS.

8461 (DOCKET-50171-94) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Emergency Rod Batteries. (Philadelphia Electric Co., Pa.). 13 Dec 1971. 2p. Dep. NTIS.

8462 (DOCKET-50206-130) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, April 1971. (Southern California Edison Co., Los Angeles). Contract AT-(30-1)-3270. 7p. (NYO-3270-49). Dep. NTIS.

8463 (DOCKET-50206-131) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, May 1971. (Southern California Edison Co., Los Angeles). Contract AT-(30-1)-3270. 7p. (NYO-3270-50). Dep. NTIS.

8464 (DOCKET-50206-132) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, June 1971. (Southern California Edison Co., Los Angeles). Contract AT-(30-1)-3270. 8p. (NYO-3270-51). Dep. NTIS.

8465 (DOCKET-50206-133) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, July 1971. (Southern California Edison Co., Los Angeles). Contract AT-(30-1)-3270. 8p. (NYO-3270-52). Dep. NTIS.

8466 (DOCKET-50206-134) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, September 1971. (Southern California Edison Co., Los Angeles). Contract AT-(30-1)-3270. 7p. (NYO-3270-54). Dep. NTIS.

8467 (DOCKET-50206-135) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Cycle 3 Xenon Transient Analysis. (Southern California Edison Co., Rosemead, Calif.). 6 Dec 1971. 3p. Dep. NTIS.

8468 (DOCKET-50213-121) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 71-8 for the Month of August. (Connecticut Yankee Atomic Power Co., Haddam). 21 Sep 1971. Contract AT(30-1)-3250. 14p. (NYO-3250-63). Dep. NTIS.

8469 (DOCKET-50213-122) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 71-9 for the Month of September. (Connecticut Yankee Atomic Power Co., Haddam). 19 Oct 1971. Contract AT(30-1)-3250. 12p. (NYO-3250-64). Dep. NTIS.

8470 (DOCKET-50213-123) HADDAM NECK PLANT. Abnormal Occurrence No. 71-1, Automatic Reactor and Turbine Trip on December 2, 1971. (Connecticut Yankee Atomic Power Co., Haddam). 8 Dec 1971. 4p. Dep. NTIS.

Inspection and corrective maintenance requirements for the undervoltage trip circuit breakers are described following a malfunction on December 2, 1971. (D.C.C.)

8471 (DOCKET-50213-124) HADDAM NECK PLANT. Operation Report No. 71-11, November 1971. (Connecticut Yankee Atomic Power Co., Haddam). 17 Dec 1971. 12p. (NYO-3250-66). Dep. NTIS.

8472 (DOCKET-50219-152) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Main Steam Valve NS03B Leakage. (Jersey Central Power and Light Co., Morristown, N. J.). 13 Dec 1971. 2p. Dep. NTIS.

8473 (DOCKET-50219-153) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Failure of main steam isolation valve NS03B to Fully Close. (Jersey Central Power and Light Co., Morristown, N. J.). 14 Dec 1971. 2p. Dep. NTIS.

8474 (DOCKET-50219-154) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Failure of Isolation Condenser DC Motor Operated Condensate Return Valve, V-14-35. (Jersey Central Power and Light Co., Morristown, N. J.). 14 Dec 1971. 3p. Dep. NTIS.

8475 (DOCKET-50244-83) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT NO. 1. Failure of "C" Safety Injection Pump. (Rochester Gas and Electric Corp., N. Y.). 14 Dec 1971. 2p. Dep. NTIS.

8476 (DOCKET-50245-108) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Abnormal Occurrence No. AO-71-25. (Millstone Point Co., Hartford, Conn.). 9 Dec 1971. 2p. Dep. NTIS.

On November 30, 1971, the gas turbine tripped on high vibration during a routine demonstration run. The trip occurred due to a power turbine lube oil temperature of 46°F instead of a nominal 90°F. The lube oil immersion heaters were not operating. (D.C.C.)

8477 (DOCKET-50247-54) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. Restoration Plan for Primary Auxiliary Building and Equipment. (Consolidated Edison Co. of New York, Inc., New York). 6 Dec 1971. 39p. Dep. NTIS.

8478 (DOCKET-50249-112) DRESDEN NUCLEAR POWER STATION, UNIT 3. Safety Valve Operation Following Feedwater Transient. (Commonwealth Edison Co., Chicago, Ill.). 17 Dec 1971. 10p. Dep. NTIS.

On December 8, 1971, a condensate booster pump tripped and caused a reactor water level transient. This water level transient resulted in filling the main steam line with water, opening of a safety valve, and pressurization of the drywell. The sequence of events, analysis of damage, and corrective actions are described. (D.C.C.)

8479 (DOCKET-50255-60) PALISADES PLANT. Difficulty Experienced in Removing Nuts from Reactor Vessel Studs. (Consumers Power Co., Jackson, Mich.). 17 Dec 1971. 10p. Dep. NTIS.

8480 (DOCKET-50255-61) PALISADES PLANT. Bending of Nut Capture Devices and Continuous Outward Driving of a Control Rod Drive Mechanism. (Consumers Power Co., Jackson, Mich.). 16 Dec 1971. 8p. Dep. NTIS.

Two problems with reactor operations are described. The bending of nut capture devices on the Type A fuel bundles is reviewed. The continuous outward driving of a control rod drive mechanism motor package while it was disconnected from the remainder of the control rod drive mechanism is also described. Corrective actions are discussed. (D.C.C.)

8481 (DOCKET-50263-94) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Abnormal Occurrence November 14, 1971. (Northern States Power Co., Minneapolis, Minn.). 15 Nov 1971. 1p. Dep. NTIS.

An explosion in the plant off-gas system on November 14, 1971, is described. (D.C.C.)

8482 (DOCKET-50269-44) OCONEE NUCLEAR STATION, UNIT 1. Review of Damaged Control Rod Drive Mechanisms. (Division of Reactor Licensing (AEC), Washington, D. C.). 6 Dec 1971. 2p. Dep. NTIS.

8483 (DOCKET-50301-46) POINT BEACH NUCLEAR PLANT, UNIT NO. 2. Repairs to the Tube Sheet Cladding of the 2A Steam Generator. (Wisconsin Electric Power Co., Milwaukee). 15 Nov 1971. 5p. Dep. NTIS.

8484 (DOCKET-50331-32) DUANE ARNOLD ENERGY CENTER. Examination of CRD Stub Tube to Bottom Head Welds. (Division of Compliance (AEC), Glen Ellyn, Ill. Region III). 7 Oct 1971. 8p. Dep. NTIS.

8485 (EFAPP-200-1) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1 OPERATING EXPERIENCE THROUGH 200 MWT. (Atomic Power Development Associates, Inc., Detroit, Mich.). Aug 1971. 298p.

Design parameters and physics measurements for the reactor are presented. The operating history of the reactor is reviewed. (D.C.C.)

8486 (NP-19134) ELEVENTH ANNUAL REPORT, 1970. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reacktor Prosjekt). 147p. Dep. NTIS (U. S. Sales Only).

Operations and maintenance requirements during January to December 1970 are reviewed. Testing programs are described. The development program for a computer control system is reviewed. Irradiation testing results for UO_2, PuO_2-UO_2, and ThO_2-UO_2 Zircaloy-clad fuel rods are presented. (12 references) (D.C.C.)

8487 (TID-25867) ARDENNES NUCLEAR POWER PLANT. Report for September 1971. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-lez-Givet (France)). 13p. Dep. NTIS.

Operations and testing activities during September 1971 are reviewed. Maintenance requirements during the month are described. (D.C.C.)

8488 (TID-25868) ARDENNES NUCLEAR POWER PLANT. Report Covering August 1971. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-lez-Givet (France)). 17p. Dep. NTIS.

Operations and testing activities during August 1971 are reviewed. Maintenance requirements during the month are described. (D.C.C.)

8489 (TID—25869) GUNDREMMINGEN NUCLEAR POWER PLANT. Monthly Report, August 1971. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany). 22 Sep 1971. 46p. (In German). Dep. NTIS.

The plant was run at full load throughout the month of August. On 15 August there was a short outage of about 10 hours due to a lightning stroke. The reactor had to be shut down because of a brief steam volume peak due to the opening of the by-pass station when the power switch operated. The activities in the reactor water and off-gas remain constantly low. (auth)

8490 EXPERIENCE IN THE OPERATION OF ATOMIC POWER PLANTS. Gaberscek, B. (Energoprojekt, Belgrade). Elektroprivreda; 24: No. 1-2, 32-9(1971). (In Serbian).

Information on the operational experiences, on the operational safety of atomic power plants, on the causes and frequencies of their shutdowns and availabilities is presented. Atomic power plants, at least light water reactors, are already past their development phase with its "teething" troubles. The availability was affected by the shutdowns for fuel replacement, planned and unforeseen maintenance work and outages. The availability, however, has been steadily improving with the years and for some plants has increased with the year of the plant in service. The frequency of failures was higher on the conventional than on the nuclear part of the plants, this being particularly noticeable in the most recent plants. A high rate of availability is reported for power plants put into service during the past few years. (auth) (INIS)

8491 TECHNIQUES AND PROBLEMS OF START UP IN NUCLEAR POWER STATIONS IN COMPARISON WITH CONVENTIONAL POWER STATIONS. Deublein, C. (Kernkfaftwerk Lingen GmbH, Darme-Lingen, Ger.); Schweiger, F. Mitt. Ver. Grosskesselbetr.; 51: No. 1, 1-8(1971). (In German).

The startup procedures at the three nuclear power stations at Lingen (boiling water reactor), Obrigheim (pressurized water reactor) and the AVR experimental nuclear power station (gas-cooled high temperature reactor) are described and compared with that for a coal-fired unit, ("Westfalen," 176 MW(e)). No essential differences in the duration of startup are evident, with the exception of the nuclear station at Lingen. Reduction in startup time in the future seems possible. (INIS)

8492 NUCLEAR VS. GAS AND OIL FUELS. Ritchings, F. A. (Ebasco Services, Inc., New York). Ingenieur (Utrecht); 22: A373-86(4 Jun 1971); 23: A392-99(11 Jun 1971).

The economics of nuclear power plants is compared to fossil-fueled power plants. Projected cost factors for natural gas and oil fired plants are presented. (H.D.R.)

Safety and Siting

Refer also to abstracts 6788 and 7020.

8493 (DOCKET-50016-136) ENRICO FERMI ATOMIC POWER PLANT. Technical Specifications, Change No. 16. (Division of Reactor Licensing (AEC), Washington, D. C.). 29 Nov 1971. 4p. Dep. NTIS.

Revised technical specifications are presented concerning the handling of fully irradiated Core A fuel in the transfer tank, the cleaning machine, and the decay and cut-up pools. (D.C.C.)

8494 (DOCKET-50146-99) SAXTON NUCLEAR EXPERIMENTAL REACTOR PROJECT. Technical Specifications, Change Report No. 27. (Saxton Nuclear Experimental Corp., Pa.). 9 Dec 1971. 5p. Dep. NTIS.

Revised technical specifications are presented concerning the addition of an evaporator feed pump to the radioactive waste disposal system. (D.C.C.)

8495 (DOCKET-50146-100) SAXTON NUCLEAR EXPERIMENTAL REACTOR PROJECT. Technical Specifications, Change No. 45. (Division of Reactor Licensing (AEC), Washington, D. C.). 1 Dec 1971. 2p. Dep. NTIS.

Revised technical specifications are presented concerning an increase in hydrogen concentrations in the primary coolant. (D.C.C.)

8496 (DOCKET-50206-129) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Technical Specifications, Proposed Changes Nos. 9 and 10. (Southern California Edison Co., Los Angeles). 7 Dec 1971. 5p. Dep. NTIS.

Revised technical specifications are presented concerning the installation of backup valves for the ventilation lines to and from the containment sphere and a reduction in the allowable leakage rate from the primary cooling system of 10 gpm to 6 gpm. (D.C.C.)

8497 (DOCKET-50219-155) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Core Spray System Water Hammer. (Jersey Central Power and Light Co., Morristown, N. J.). 15 Dec 1971. 40p. Dep. NTIS.

8498 (DOCKET-50237-208) DRESDEN NUCLEAR POWER STATION, UNIT 2. Sensitized Stainless Steel Safe Ends. (Commonwealth Edison Co., Chicago, Ill.). 13 Dec 1971. 4p. Dep. NTIS.

8499 (DOCKET-50261-81) H. B. ROBINSON UNIT NO. 2. Emergency Core Cooling System, Supplemental Information to Letters of September 29, 1971 and November 5, 1971. (Carolina Power and Light Co., Raleigh, N. C.). 8 Dec 1971. 8p. Dep. NTIS.

8500 (DOCKET-50263-92) MONTICELLO NUCLEAR GENERATING PLANT. Supplemental Information for Change Request No. 2. (Northern States Power Co., Minneapolis, Minn.). 10 Dec 1971. 48p. Dep. NTIS.

Requested additional data are presented concerning shock wave attenuation in the recombiner system and dilution flow characteristics for the off-gas stack. (D.C.C.)

8501 (DOCKET-50263-93) MONTICELLO NUCLEAR GENERATING PLANT. Damage to Torus Baffles. (Northern States Power Co., Minneapolis, Minn.). 15 Dec 1971. 6p. Dep. NTIS.

8502 (DOCKET-50269-42) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Final Safety Analysis Report, Revision No. 17, Supplement 10. (Duke Power Co., Charlotte, N. C.). 17 Dec 1971. 72p. (DOCKET-50270-37; DOCKET-50287-34). Dep. NTIS.

Performance evaluation for the emergency core cooling systems of the Oconee Power Reactor Units 1, 2, and 3 is presented for operations with pressurized and unpressurized fuel pins. (D.C.C.)

8503 (DOCKET-50269-43) OCONEE NUCLEAR STATION, UNIT 1. Draft Detailed Statement on Environmental Considerations. (Division of Reactor Licensing (AEC), Washington, D. C.). 13 Dec 1971. 164p. Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Geological, hydrological, and meteorological data for the reactor site are presented. (D.C.C.)

8504 (DOCKET-50271-66) VERMONT YANKEE NUCLEAR POWER STATION. Clarifying Details on the Addition of Vacuum Breakers. (Vermont Yankee Nuclear Power Corp., Rutland). 30 Nov 1971. 2p. Dep. NTIS.

Information is presented concerning the addition of a vacuum check valve in each of the turbine exhaust lines from the high pressure coolant injection and reactor core isolation cooling systems. (D.C.C.)

8505 (DOCKET-50277-40) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Construction Details. (Philadelphia Electric Co., Pa.). 19 Nov 1971. 12p. (DOCKET-50278-30). Dep. NTIS.

8506 (DOCKET-50280-59) SURRY POWER STATION, UNIT NO. 1. Discussion of Inspections of Construction Activities. (Division of Compliance (AEC), Atlanta, Ga. Region II). 1 Sep 1971. 8p. Dep. NTIS.

Information concerning the quality assurance of welds in piping systems is presented. (D.C.C.)

8507 (DOCKET-50280-60) SURRY POWER STATION, UNITS 1 AND 2. Requirement for Two Licensed Senior Operators. (Virginia Electric and Power Co., Richmond). 17 Dec 1971. 1p. (DOCKET-50281-56). Dep. NTIS.

8508 (DOCKET-50285-52) FORT CALHOUN STATION, UNIT NO. 1. Final Safety Analysis Report, Supplement No. 13. (Omaha Public Power District, Nebr.). 16 Dec 1971. 170p. Dep. NTIS.

Revised design parameters of the Fort Calhoun Power Reactor Unit 1 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

8509 (DOCKET-50289-43) THREE MILE ISLAND NUCLEAR STATION, UNITS 1 AND 2. Revised Environmental Report, Operating License Stage. (Metropolitan Edison Co., Reading, Pa.). 10 Dec 1971. 403p. (DOCKET-50320-25). Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Hydrological and meteorological data for the reactor site are included. (D.C.C.)

8510 (DOCKET-50289-44) THREE MILE ISLAND NUCLEAR STATION, UNITS 1 AND 2. Discussions and Findings Relative to Suspension of Provisional Construction Permits

Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 29 Nov 1971. 35p. (DOCKET-50320-26). Dep. NTIS.

8511 (DOCKET-50295-34) ZION STATION, UNITS 1 AND 2. Environmental Report, Supplement 2. (Commonwealth Edison Co., Chicago, Ill.). 3 Dec 1971. 427p. (DOCKET-50304-33). Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactors is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

8512 (DOCKET-50295-35) ZION STATION, UNITS 1 AND 2. Final Safety Analysis Report, Amendment No. 17. (Commonwealth Edison Co., Chicago, Ill.). 10 Dec 1971. 295p. (DOCKET-50304-34). Dep. NTIS.

Revised design parameters of the Zion Power Reactor Units 1 and 2 are presented. Included are additional data on the reactors requested by the Division of Reactor Licensing. Performance evaluation of the emergency core cooling systems is also included. (D.C.C.)

8513 (DOCKET-50305-31) KEWAUNEE NUCLEAR POWER PLANT. Final Safety Analysis Report, Amendment No. 13. (Wisconsin Public Service Corp., Green Bay). 15 Dec 1971. 391p. Dep. NTIS.

Revised technical specifications for the reactor are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

8514 (DOCKET-50309-45) MAINE YANKEE ATOMIC POWER STATION. Environmental Studies, Second Annual Report. (Maine Yankee Atomic Power Co., Westboro, Mass.). 7 Dec 1971. 364p. Dep. NTIS.

Revised and additional hydrological, limnological, and meteorological data for the reactor site are presented. (D.C.C.)

8515 (DOCKET-50312-30) RANCHO SECO NUCLEAR GENERATING STATION, UNIT 1. Final Safety Analysis Report, Amendment No. 6. (Sacramento Municipal Utility District, Calif.). 6 Dec 1971. 775p. Dep. NTIS.

Revised and additional data on design parameters and operations aspects are presented. Technical specifications are included. (D.C.C.)

8516 (DOCKET-50312-31) RANCHO SECO NUCLEAR GENERATING STATION, UNIT 1. Final Safety Analysis Report, Amendment No. 7. (Sacramento Municipal Utility District, Calif.). 15 Dec 1971. 47p. Dep. NTIS.

Additional meteorological data for the reactor site are presented. (D.C.C.)

8517 (DOCKET-50313-34) ARKANSAS NUCLEAR ONE, UNIT 1. Final Safety Analysis Report, Amendment No. 22. (Arkansas Power and Light Co., Little Rock). 14 Dec 1971. 261p. Dep. NTIS.

Revised design parameters of the Arkansas Nuclear One Power Reactor are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

8518 (DOCKET-50313-35) ARKANSAS NUCLEAR ONE, UNIT 1. Discussions and Findings Relative to Suspension of Construction Permit Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 23 Nov 1971. 18p. Dep. NTIS.

8519 (DOCKET-50315-55) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Analysis of Ice Condenser Containment System. (Indiana and Michigan Power Co., New York). 13 Dec 1971. 6p. (DOCKET-50316-55). Dep. NTIS.

8520 (DOCKET-50324-27) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Answer to Order to Show Cause, Volume 3. (Carolina Power and Light Co., Raleigh, N. C.). 15 Dec 1971. 213p. (DOCKET-50325-27). Dep. NTIS.

Information is presented concerning the environmental aspects of transmission lines. (D.C.C.)

8521 (DOCKET-50324-28) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Answer to Order to Show Cause, Volume 1. (Carolina Power and Light Co., Raleigh, N. C.). 15 Dec 1971. 125p. (DOCKET-50325-28). Dep. NTIS.

Additional information is presented concerning thermal discharges from the reactors, site preparation for the thermal effluent release system, preoperational and startup testing, and environmental aspects of transmission lines. (D.C.C.)

8522 (DOCKET-50324-29) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Answer to Order to Show Cause, Volume 2. (Carolina Power and Light Co., Raleigh, N. C.). 15 Dec 1971. 261p. (DOCKET-50325-29). Dep. NTIS.

Additional data are presented concerning thermal discharges from the reactors and site preparation. (D.C.C.)

8523 (DOCKET-50333-37) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Final Safety Analysis Report, Supplement No. 3. (Power Authority of the State of New York). 13 Dec 1971. 118p. Dep. NTIS.

Revised and additional data are presented on the design parameters and operations aspects of the reactor. (D.C.C.)

8524 (DOCKET-50335-22) HUTCHINSON ISLAND PLANT, UNIT NO. 1. Discussions and Findings Relating to Suspension Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 2 Dec 1971. 24p. Dep. NTIS.

8525 (DOCKET-50338-33) NORTH ANNA POWER STATION, UNITS 1 AND 2. Comments Concerning Items Listed in Enclosure to Letter of March 18, 1971. (Virginia Electric and Power Co., Richmond). 14 Apr 1971. 10p. (DOCKET-50339-32). Dep. NTIS.

Inspection findings and comments are presented concerning quality assurance and welding procedures. (D.C.C.)

8526 (DOCKET-50341-35) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Environmental Report Construction Permit Stage (Revised), Supplements, Changes, and Errata. (Detroit Edison Co., Mich.). 14 Dec 1971. 107p. Dep. NTIS.

Revised and additional data are presented concerning the radioactive discharges from the reactor. The effects of reactor operations on the environment are analyzed. (D.C.C.)

8527 (DOCKET-50344-25) TROJAN NUCLEAR PLANT. Supplemental Environmental Report, Amendment No. 1. (Portland General Electric Co., Oreg.). 22 Nov 1971. 9p. Dep. NTIS.

Surface water data for the reactor site are presented. (D.C.C.)

8528 (DOCKET-50348-30) JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment No. 24. (Alabama Power Co., Birmingham). 7 Dec 1971. 76p. (DOCKET-50364-24). Dep. NTIS.

Performance evaluation for the emergency core cooling system during pipe break accidents is presented. (D.C.C.)

8529 (DOCKET-50352-23) LIMERICK GENERATING STATION, UNITS 1 AND 2. Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). 29 Nov 1971. 178p. (DOCKET-50353-23). Dep. NTIS.

8530 (DOCKET-50354-19) NEWBOLD ISLAND NUCLEAR GENERATING STATION, UNITS 1 AND 2. Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). 17 Dec 1971. 156p. (DOCKET-50355-19). Dep. NTIS.

8531 (DOCKET-50354-20) NEWBOLD ISLAND NUCLEAR GENERATING STATION. Preliminary Safety Analysis Report, Amendment 12. (Public Service Electric and and Gas Co., Newark, N. J.). 3 Dec 1971. 10p. (DOCKET-50355-20). Dep. NTIS.

Financial data on the owners of the Newbold Island Power Reactor Units 1 and 2 are presented. Cost estimates for the reactors are included. (D.C.C.)

8532 (DOCKET-50367-25) BAILLY GENERATING STATION, NUCLEAR I. Assurance Items Listed by ACRS will be Resolved in an Acceptable Manner. (Northern Indiana Public Service Co., Hammond). 29 Nov 1971. 4p. Dep. NTIS.

Revised and additional design parameters and operating procedures for the Bailly Power Reactor Unit 1 are presented. (D.C.C.)

8533 (DOCKET-50368-20) ARKANSAS NUCLEAR ONE, UNIT 2. Preliminary Safety Analysis Report, Amendment No. 16. (Arkansas Power and Light Co., Little Rock). 8 Dec 1971. 67p. Dep. NTIS.

Revised design parameters of the Arkansas Nuclear One Power Reactor Unit 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

8534 (DOCKET-50368-21) ARKANSAS NUCLEAR ONE, UNIT 1. Preliminary Safety Analysis Report, Amendment No. 17. (Arkansas Power and Light Co., Little Rock). 13 Dec 1971. 73p. Dep. NTIS.

Performance evaluation for the emergency core cooling system is presented. (D.C.C.)

8535 (DOCKET-50369-17) McGUIRE NUCLEAR STATION, UNITS 1 AND 2. Request to Withhold Certain Proprietary Report from Public Disclosure. (Duke Power Co., Charlotte, N. C.). 6 Dec 1971. 37p. (DOCKET-50370-16). Dep. NTIS.

Summaries of reports containing information on control systems, coolant loss accident conditions, core physics, and ice condenser containment system performance are presented. (D.C.C.)

8536 (FIND-50368(12-71)) FIND: ARKANSAS NUCLEAR ONE, UNIT 2. Revision 1. Smith, James G. (ed.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). 3 Dec 1971. 10p. Dep. NTIS.

An index to microfiche issuances of safety analysis reports is provided. Subject citations are to specific frames on the microfiche. (J.M.J.)

8537 AEC LICENSING PROCEDURE AND RELATED LEGISLATION. PART 1. HEARINGS BEFORE THE SUBCOMMITTEE ON LEGISLATION OF THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-SECOND CONGRESS, FIRST SESSION, JUNE 22, 23; JULY 13, AND 14, 1971. Washington, D. C.: Joint Committee on Atomic Energy (1971). 489p. GPO $1.75.

During 1970 a number of developments occurred which significantly affect the U. S. Atomic Energy Commission's procedures for licensing and regulating nuclear reactors. Among these developments were the enactment of the National Environmental Policy Act and the Water Quality Improvement Act and the assignment of responsibility for environmental radiation standards to the Environmental Protection Agency. The impact of these developments on the licensing process and proposals for improvements to reactor licensing procedures are discussed in detail. (H.D.R.)

8538 AEC LICENSING PROCEDURE AND RELATED LEGISLATION. PART 2. HEARINGS BEFORE THE SUBCOMMITTEE ON LEGISLATION OF THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-SECOND CONGRESS, FIRST SESSION, APPENDIXES 1 THROUGH 28. Washington, D. C.: Joint Committee on Atomic Energy (1971). 678p. GPO $2.75.

8539 AEC LICENSING PROCEDURE AND RELATED LEGISLATION. PART 3. HEARINGS BEFORE THE SUBCOMMITTEE ON LEGISLATION OF THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-SECOND CONGRESS, FIRST SESSION, APPENDIXES 29 THROUGH 46. Washington, D. C.: Joint Committee on Atomic Energy (1971). 498p. GPO $1.75.

8540 AEC LICENSING PROCEDURE AND RELATED LEGISLATION. PART 4. HEARINGS BEFORE THE SUBCOMMITTEE ON LEGISLATION OF THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-SECOND CONGRESS, FIRST SESSION, APPENDIXES 47 THROUGH 60. Washington, D. C.: Joint Committee on Atomic Energy: (1971). 466p. GPO $2.00.

Power Reactor Development

Refer also to abstract 6822.

8541 (ANL-7633) THREE-DIMENSIONAL GRAPHICAL REPRESENTATION OF SURFACES BY COMPUTER (FAST REACTOR CONTAINMENT PROGRAM). Basinger, D.; Gvildys, J. (Argonne National Lab., Ill.). Nov 1971. Contract W-31-109-eng-38. 54p. Dep. NTIS.

Plot 3D is a package of FORTRAN IV Subprograms designed to draw three-dimensional surfaces from arrays of points (x,y,z). The surfaces can be drawn after arbitrary rotations about the three coordinate axes. Four versions of Plot 3D are described. Output of Versions 1 and 3 is by film recorder. Output of Versions 2 and 4 is by Calcomp Plotter. Versions 3 and 4 do not draw lines which would be invisible to a viewer looking at an opaque surface, whereas Versions 1 and 2 draw every line on the surface. Plot 3D is described along with its limitations. Sample output and listings of the subprograms are included. (auth)

8542 (ANL-EBR-42) CORE-LOADING DIAGRAMS FOR EBR-II RUNS 39 THROUGH 50 (DECEMBER 1969 THROUGH MID-AUGUST 1971). Case, J. C. (comp.) (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Sep 1971. Contract W-31-109-eng-38. 85p. Dep. NTIS.

Core-loading diagrams for EBR-II runs are presented in chronological order. Core size, operating dates, power generation, and the number and general types of subassemblies in the core are tabulated for each run. (H.D.R.)

8543 (BMBW-FBK-71-10) GERMAN PARTICIPATION IN THE NSPE PROGRAM. Eitler, P. (Allgemeine Elektricitaets-Gesellschaft, AEG-Telefunken, Grosswelzheim (West Germany)). Sep 1971. 161p. (In German). Dep. NTIS (U. S. Sales Only).

Within the NSPE-Program a German–American cooperation in the field of nuclear superheat was accomplished. Under German participation the operation performance of the EVESR reactor was evaluated, radiochemical investigations were performed, and design studies for a 600 MW(e) Mixed Spectrum Superheat Reactor and a 100 MW(e) prototype were worked out. The EVESR reached an availability of 81 and an efficiency of 50%. Out of the 502 fuel rods irradiated only 1% failed during operation. The activity release always could be controlled. The MSSR concept proved to be technically feasible and economically attractive. (auth)

8544 FLUID-COOLED NUCLEAR REACTORS. Whalley, David (to British Nuclear Design and Construction Ltd.). British Patent 1,252,519. 3 Nov 1971. Filed 7 Oct 1969.

Reference is made to systems for the fuelling of gas cooled reactors. A problem that may arise during this operation is radial oscillation of fuel assemblies under the action of coolant gas ("rattling") which can have a damaging effect on an assembly. The system described employs baffle means to reduce radial oscillation. This baffle means may comprise hoops extending around the fuel assembly guide tubes, or a cylindrical perforated shroud around the guide tube. (UK)

8545 SIGNIFICANCE OF FAST NEUTRON INDUCED VOIDS IN THE DESIGN AND PERFORMANCE OF FAST REACTORS. Bishop, J. F. W. (United Kingdom Atomic Energy Authority, Risley, Eng.). J. Brit. Nucl. Energy Soc.; 10: No. 4, 321-8(Oct 1971).

The experimental information available on void swell and irradiation creep of stainless steel and Nimonic PE 16 is presented. It is shown how these phenomena must be accounted for in the design of large fast reactors such as PFR. The consequences of void swelling on the design consideration of fuel pins and sub-assemblies and on core concepts and reactor structure are examined. Indications are that the use of low swelling materials such as Nimonic PE 16 or an optimised cold-worked stainless steel for sub-assembly wrappers would permit the use of an unrestrained core. Selection of material for a restrained core requires irradiation creep data based on higher dose rates than those available at present. (UK)

8546 CORE STRUCTURES FOR NUCLEAR REACTORS. Pettinger, Donald Stanley (to Nuclear Power Group Ltd.). British Patent 1,253,358. 10 Nov 1971. Filed 3 Feb 1969.

Reference is made to graphite moderator core structures. With reactors operating in the lower temperature ranges the coolant is circulated only through a central fuel-containing channel in each block, but with the advent of high temperature reactors additional cooling of the graphite blocks is necessary, requiring the formation of internal ducts in the blocks. Furthermore, with very high temperature reactors the fuel may be dispersed in a number of passages in the blocks, rather than in a single central passage. The need to form graphite blocks having a multiplicity of passages for coolant or fuel creates manufacturing problems, particularly in drilling such passages in blocks of substantial length. Blocks are described having mechanical passages, with at least some of the sides of each passage flat and straight; this avoids some of the manufacturing problems, since the passages can be formed using mortise chain cutting gear of the kind commonly used for timber. A number of arrangements for the passages are described. (UK)

8547 IMPROVEMENTS TO NUCLEAR PLANTS UTILIZING PRESSURE TUBES, PARTICULARLY FOR ENERGY PRODUCTION. (to Societe Babcock-Atlantique). French Patent 2,054,427. 23 Apr 1971. Filed 25 Feb 1969. (In French).

An improvement to nuclear plants utilizing pressure tube type reactors (tubes containing the nuclear fuel, in which the primary fluid circulates) is described. An arrangement is proposed, which makes available a space normally occupied by the tubulures. A replacement tubulure, which can be used to substitute a faulty one, occupies this space; the replacement procedure can be carried out without demounting the assembly. (France)

8548 NUCLEAR REACTOR MODERATING CORE STRUCTURE. Sage, Frederick (to United Kingdom Atomic Energy

Authority). British Patent 1,253,245. 10 Nov 1971. Filed 1 Mar 1968.

Reference is made to core structures comprising an array of columns of graphite blocks. During reactor operation displacement of columns may occur, owing to dimensional changes of the blocks. The arrangement described seeks to provide a means whereby the possibility of displacement is reduced; it comprises an array of columns with the blocks having side faces inclined to the vertical, the blocks in adjacent columns having wedge shaped pieces of graphite interposed between them. The faces of these pieces and the inclined side faces of the blocks are complementary to each other, the inclination of the faces to the vertical being less than the angle of friction between the blocks and the pieces. Provision can be made for moderator cooling by perforating the pieces or by leaving gaps between them. The inclined faces can be extended the entire width and length of the blocks or take the form of recesses; recessed side faces will normally be used with non-perforated pieces. A rigid restraint means, such as a steel cylinder, may be provided around the core structure, and an outer region may comprise an unfuelled reflector portion. (UK)

Kinetics and Dynamics

8549 (AI-AEC-13013) LMFBR PHYSICS PROGRAMS. Quarterly Technical Progress Report, July-September 1971. (Atomics International, Canoga Park, Calif.). 15 Nov 1971. Contracts AT(04-3)-701; AT(04-3)-824. 40p. Dep. NTIS.

CRITICAL ASSEMBLIES—physics parameters of fast benchmark cores in, (E/T)
—neutron importance distribution in ECEL, axial fission, (E/T)
—Doppler coefficient measurements in ZPPR-2, (E)
LIQUID METAL FAST BREEDER REACTOR—physics measurement programs during July to September 1971
NEUTRON CROSS SECTIONS—calculations for fast assemblies, evaluation of ENDF/B data for, (E/T)
PLUTONIUM 239—neutron cross sections for, evaluation of ENDF/B data for, (E/T)
REACTOR CONTROL ELEMENTS—reactivity worths of fast, effects of absorber and structural materials on, (E/T)
REACTORS, FAST—physics calculations for, development of VIM computer program for
URANIUM 235—neutron cross sections for, evaluation of ENDF/B data for, (E/T) (H.D.R.)

Control Systems

8550 (CONF-710935-3) MORE EFFICIENT CONTROL ROOM OPERATOR-PROCESS INTERFACE. Paper No. 71 TP 704-PWR. Calvo, J. A. (Bechtel Corp., San Francisco, Calif.); Jones, R. T. (Philadelphia Electric Co., Pa.). 1 Jul 1971. 8p. IEEE, New York $1.35.

From Joint power generation conference; St. Louis, Mo. (19 Sep 1971).

The results of a study to reduce the size of a typical boiling water reactor (BWR) power plant control room and to provide a more efficient operator interface with the process are presented. Conventional "hard-wired" instrumentation and computer-driven cathode ray tubes (CRTs) were used to implement the functional requirements in each of the four alternatives established for study. The results were conclusive indicating that the study objectives can be met within the realm of current technology. (auth)

8551 CONTROL OF NUCLEAR REACTORS. Johnson, Frank Geoffrey (to United Kingdom Atomic Energy Authority). British Patent 1,253,365. 10 Nov 1971. Filed 4 Jul 1968.

Reference is made to methods of controlling heterogeneous reactors. In the system described, discrete streams of a neutron absorbing gaseous mixture are conducted into and out of the core, and the activity of the streams leaving the core is monitored so as to initiate control signals proportional to the differential in the activities which vary the pressure of the streams and thus control and stabilize reactivity throughout the core. The gaseous mixture may include Ar and either ^{3}He, Kr or Xe, and may be passed through tubes extending through the core substantially parallel to the coolant conducting channels. Continuous samples of the mixture are taken from the tubes and compared for ^{41}Ar content, which is used to monitor the pressure of the mixture. Where the reactor has a cylindrical moderator mass the tubes may extend end-to-end of the mass and be arranged in concentric zones for power shaping control, and in sectors for sector control. (UK)

8552 TRIAL MANUFACTURE OF BWR TYPE CONTROL RODS AND CONTROL ROD DRIVE MECHANISMS AND THEIR EXAMINATION. Masuda, Takahisa; Futatsugi, Masao (Tokyo Shibaura Electric Co. Ltd.,). Karyoku Hatsuden; 22: No. 1, 76-81(Jan 1971). (In Japanese).

In order to manufacture control rods and drive mechanisms domestically, first trial manufacture and examination started in 1963. In 1967, a control rod of new type and its drive mechanism were made as the trial manufacture. Their performance and endurance were examined and compared with products of GE, and were satisfactory. Then trial mass production was done, and it was proved that the products have negligible variation in their performance. (Japan)

8553 APPLICATION OF PROCESS CONTROL COMPUTERS IN NUCLEAR POWER PLANTS. Jaschek, H. (Technische Univ., Munich). Arch. Tech. Messen; 425: No. 6, 121-6(1971). (In German).

Presented are various application possibilities of a process-control computer in nuclear power plants, not only for data collection and processing but also for process control and supervision, and some examples as to its use in practice are given. An outlook on future application is given as a conclusion. (INIS)

Shielding

8554 (ORNL-TM-3639) FAST REACTOR SHIELDING MONTHLY PROGRESS REPORT FOR OCTOBER 1971, 189A NO. 10028, ACTIVITY NO. 40 01 61. Mynatt, F. R.; Clifford, C. E.; Gritzner, M. L.; Maerker, R. E.; McGregor, B. J. (Oak Ridge National Lab., Tenn.). 24 Nov 1971. 40p. Dep. NTIS.

FAST TEST REACTOR—neutron flux in cavity area of, effects of stored fuel elements on, (T)
—shielding for, effects of stored fuel on requirements for cavity, (T)
—shielding for, effects of neutron streaming in fission gas plenum on, (T)
LIQUID METAL FAST BREEDER REACTOR—coolant for, neutron shielding effects of sodium, (E/T)
NEUTRONS—attenuation in liquid sodium, (E/T)
SODIUM—neutron attenuation in, (E/T) (H.D.R.)

Cooling Systems

8555 (CONF-710903-6) SCANDINAVIAN PCRV MODEL PROJECT: THERMAL INSULATION TESTS. Kraemer, W. (ASEA-ATOM, Vasteras (Sweden)); JHernborg, G.; Menon, S.; Johnsson, B. (Aktiebolaget Atomenergi, Studsvik (Sweden)). [nd]. 18p. Dep. NTIS (U. S. Sales Only).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

Some of the insulation tests carried out under a development program in the field of prestressed concrete reactor vessels for water reactors are described. The Scandinavian PCRV concept is characterized by a removable insulation, allowing for erection of the insulation outside the pressure vessel, for repair of the insulation if serious defects should arise after many years of operation, and for inspection of the vessel liner. The insulation, as well as the space between the insulation and the vessel liner, are filled with gas or alternatively with water. A multipurpose test facility was built in mainly for testing the novel designs of the removable lid and of the insulation systems. The model vessel is approximately to scale 1:3.5 relative to a reactor vessel for an 800 MW(e) BWR. The vessel is insulated by stainless steel insulation of the "Metalisol" type (from France). It is bolted on to the outside of a removable "casing," which encloses the reactor internals. The model can be pressurized either by cold or hot water or by saturated steam up to 85 bar (300°C). There are various other auxiliary systems for level control, lining cooling etc. A first test series was concluded in December 1970. This series included operation at service conditions (70 bar, 285°C) and at design pressure (85 bar, 300°C) with gas and water-filled insulation, tests with vessel pressure oscillations, transient tests including fast depressurization of the steam dome or sudden flooding of the insulation system with hot water near saturation temperature. The excellent performance of the insulation system is demonstrated by typical "temperature maps," print-outs of the data reduction program developed for the evaluation of the thermal insulation tests. (auth)

8556 (HPR-143) MILD STEEL IN THE PRIMARY CIRCUIT OF WATER COOLED REACTORS. Videm, K.; Lunde, L.; Aas, S.; Fjellestad, K. (Institutt for Atomenergie, Halden (Norway). OECD Halden Reaktor Prosjekt). Sep 1971. 19p. Dep. NTIS (U. S. Sales Only).

A study was initiated in the late 1950's of the properties of mild steel in a boiling water reactor environment. As part of this program the steam pipes of the Halden Boiling Water Reactor (HBWR) were made of mild steel. The work was continued in the 1960's with loop experiments and by exposing specimens in various locations in the primary system of the reactor. Since 1964 the specimens have been exposed continuously and certain aspects of the corrosion problem have been studied by loop experiments. In order to gain experience with major pieces of equipment, a subcooler heat exchanger made of mild steel was installed in the primary circuit in 1967. The unit was removed in 1970 and inspected. The results since 1964 are summarized. 9 references. (auth)

8557 (ZJE-111) EXPERIMENTAL INVESTIGATION OF MOMENTUM AND HEAT TRANSFER IN TURBULENT FLOW OF AIR IN A FUEL ASSEMBLY MODEL. Vlcek, J. (Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Construction Dept.). 1971. 16p. Dep. NTIS (U. S. Sales Only).

The distribution of rods in a fuel assembly is usually calculated using the assumption that there is no turbulent mixing of coolant among adjoining circular rows of rods, and that all the heat generated in a rod is transferred into the subchannel corresponding to the rod under consideration. This problem was solved experimentally using certain arrangement of smooth heated rods situated in a circular channel. The experimental effort was performed on an air loop with an inlet pressure of 5 kp/cm^2, the maximum value of Re being 2×10^5. 10 references. (auth)

8558 THEORETICAL STUDY OF TWO-PHASE FLOW OSCILLATION IN A HOT CHANNEL. I. THEORETICAL STUDY FOR INTERPRETING THE MECHANISM OF HYDRODYNAMIC INSTABILITY. Takahashi, Ryoichi; Shindo, Masuo (Tokyo Inst. of Tech.). J. Nucl. Sci. Technol. (Tokyo); 8: No. 11, 637-43(Nov 1971).

Spontaneous two-phase flow oscillation, which can induce reactivity instability in BWR, is studied by numerical simulation, using a Fortran code. It is indicated that unstable flow is much more influenced by heat transfer characteristics than currently believed. Particular attention is paid to such processes as energy storage, dissipation and transformation. Nonlinear flow oscillation of two-phase flow is dominantly governed by exchangers of heat between fluid and channel wall, which alternatively stores and releases the heat energy. 10 references. (auth)

8559 CONTRIBUTION TO PRESSURE LOSS IN HELICALLY COILED STEEL TUBES. Barthels, H.; Scholz, F. (Kernforschungsanlage, Juelich, Ger.). Atomwirt., Atomtech.; 16: No. 12, 639-40(Dec 1971). (In German).

Almost all modern gas-cooled nuclear power plants possess steam producers consisting in helically coiled tubes. The present experiments were performed on steel tubes with an internal diameter of 13 mm, a wall thickness of 2 mm, and a total length of 6000 mm. Under isothermal conditions, air was blown through the tubes and the resistance was measured especially for Reynolds figures from 10^4 to 10^6. Pressure loss measurements were performed with respect to internal roughness of the tubes and curvature of the coils. (H.B.G.)

8560 OBJECTIVE AND DESIGN OF THE GAS-CLEANING INSTALLATION OF THE THORIUM HIGH TEMPERATURE REACTOR. Manhart, K.; Schoening, J. BBC-Nachr.; 53: No. 3-4, 32-6(1971). (In German).

A description is given of design and objectives of a helium gas-cleaning installation as will be used for the THTR of the power plant Schmehausen. (INIS)

Fuels

8561 (BMI-1918) PROGRESS ON DEVELOPMENT OF FUELS AND TECHNOLOGY FOR ADVANCED REACTORS DURING JULY 1970 THROUGH JUNE 1971. Annual Report, Task 6 (Part 1) and Task 7. Final Report, Task 6 (Part 2). Keller, Donald L. (Battelle Columbus Labs., Ohio). Jul 1971. Contract W-7405-eng-92. 324p. Dep. NTIS.

EXPERIMENTAL BREEDER REACTOR-II—fuel pins for, fabrication and irradiation testing of plutonium nitride–uranium nitride
LIQUID METAL FAST BREEDER REACTOR—fuels for, development of plutonium nitride–uranium nitride, (E)
—fuels for, high temperature irradiation performance of, (E/T)
—fuels for, effects of fission process on creep of, (E/T)
NITROGEN—diffusion in plutonium nitride–uranium nitride fuels, self, (E)
PLUTONIUM NITRIDES—PuN–UN, volatilization of, effects of oxygen impurity on, (E)
—PuN–UN, self-diffusion of nitrogen in, (E)
—PuN–UN, irradiation testing of fuels of
—PuN–UN, radiation effects on high temperature swelling, fission gas release, and microstructure of, (E/T)
PLUTONIUM OXIDES PuO_2—PuO_2–UO_2, radiation effects on high temperature swelling, fission gas release, and microstructure of, (E/T)
—PuO_2–UO_2, creep of, effects of fission process on, (E/T)
REACTOR FUEL ELEMENTS—development of sodium-bonded stainless steel clad plutonium nitride–uranium nitride, (E)
—performance of stainless steel clad plutonium nitride–uranium nitride, during transient irradiation, (E/T)
—swelling of, mathematical model of mechanics of
REACTOR FUELS—creep of fast, effects of fission process on, (E/T)
—radiation effects on performance of fast, at high temperature, (E/T)
REACTOR SAFETY EXPERIMENTS—fuel element irradiation in TREAT, analysis of stainless steel clad plutonium nitride–uranium nitride, (E/T)
URANIUM CARBIDES—radiation effects on high temperature swelling, fission gas release, and microstructure of, (E/T)
—fission gas diffusion and bubble growth in, (E/T)
URANIUM NITRIDES—PuN–UN, volatilization of, effects of oxygen impurity on, (E)
—PuN–UN, self-diffusion of nitrogen in, (E)
—PuN–UN, irradiation testing of fuels of
—radiation effects on high temperature swelling, fission gas release, and microstructure of, (E/T)
—PuN–UN, radiation effects on high temperature swelling, fission gas release, and microstructure of, (E/T)
URANIUM OXIDES—stoichiometry control of, (E)
URANIUM OXIDES UO_2—PuO_2–UO_2, creep of, effects of fission process on, (E/T)
—creep of, effects of fission process on, (E/T)
—radiation effects on high temperature swelling, fission gas release, and microstructure of, (E/T)
—fission gas diffusion and bubble growth in, (E/T)
—PuO_2–UO_2, radiation effects on high temperature swelling, fission gas release, and microstructure of, (E/T)
—crystal structure of, morphology and migration of lenticular voids in, (E/T) (H.D.R.)

8562 (BNWL-SA-3855) THERMAL REACTOR PLUTONIUM FUEL IRRADIATION PROGRAMS IN THE UNITED STATES. Dawson, F. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1971]. 10p. (CONF-710616-5). Dep. NTIS. From Panel on plutonium recycling in thermal power reactors; Vienna, Austria (21 Jun 1971).

Plutonium recycle programs at the Plutonium Recycle Test Reactor, Saxton reactor, Big Rock Point reactor, San Onofre reactor, and Dresden reactor are briefly described and their status is reported. 9 references. (H.D.R.)

8563 (HPR-129) ASSESSMENT OF THE IFA-116 AND 117 IRRADIATIONS FROM DATA OBTAINED FROM THE IN-REACTOR INSTRUMENTATION. Ainscough, J. B. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Apr 1971. 75p. Dep. NTIS (U. S. Sales Only).

The information provided by the fuel center thermocouples and the diaphragm gas pressure transducers on six pins of the IFA-116 and 117 irradiations (pins 1 and 5 of the former and 1, 3, 5 and 6 of the latter) was assessed in order to derive a temperature zone model of fission gas release, suitable for use with highly rated pins in HBWR and valid at least up to 1% heavy atom burnup. From the calculated assembly heat outputs and the gamma thermometer readings, which give a measure of the axial power shape, pin ratings were estimated as was the cross cluster tilt in IFA-117. These ratings were used to calculate fuel center temperatures throughout life using the SUPATRICE computer program but with an oxide conductivity curve which differs from that determined at Halden. In five of the six pins, gas pressure build up can either be described fairly closely or else overpredicted by a model which assumes no gas release below 1200°C, 5% between 1200 and 1600°C, 30% between 1600 and 1800°C and 100% above 1800°C. The one exception, where there is a serious underpredication of gas pressure, is IFA-117 pin 3, the only pin with a stack composed entirely of hollow UO_2 pellets. It is suggested that geometry changes due to gas bubble swelling may have led to partial or complete closure of the center hole with consequent increases in fuel temperature and gas release rate. It also appears that after a major power cycle the fuel and cladding do not immediately take up the positions relative to each other that they had before the cycle and this shows itself as a higher indicated fuel center temperature. The relative alignment changes over some tens of hours gradually giving closer fuel/cladding contact and a consequent reduction in fuel center temperature. The magnitude of these temperature rises decreases with increasing burnup. 18 references. (auth)

8564 (HPR-142) POST-IRRADIATION EXAMINATION AND MODE OF FAILURE OF THE DUTCH FUEL ASSEMBLY IFA-103, IRRADIATED IN THE HALDEN BOILING WATER REACTOR. van der Linde, A. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Apr 1971. 119p. Dep. NTIS (U. S. Sales Only).

Three out of seven fuel pins in the IFA-103 test assembly failed after operation in the Halden Boiling Water Reactor. Post-irradiation examination of the longitudinally cracked, Zircaloy-2 clad fuel pins revealed that in two of the failed pins the tantalum tube, incorporated in the center of the vibrationally compacted fuel stack, was locally attacked. Moreover, one of these pins had a top weld which was attacked from the inside by a stainless steel spring during welding. The formation of Zr-Fe-Cr and Zr-Fe-Ni eutectics in the heat affected zone of the cladding resulted in hair cracks and a blistered ring on the outer surface. Although these phenomena contributed to the severity of the clad failures, the primary action resulting in the first clad fracture was attributed to a very local fuel-clad interaction. It was found that at sites where a fuel particle was pressed firmly against the inner clad wall, oxygen and, when present in the pin interior, also hydrogen was absorbed in the cladding. This phenomenon resulted in the formation of a sunburst, a spherical zone around the fuel-clad contact which was enriched in oxygen and depleted in hydrogen. This sunburst, as observed at room temperature, was surrounded by radially oriented hydrides. Absorption of oxygen resulted in local deterioration of clad ductility properties so that in combination with the increase in stress imposed on the cladding by the expanding zirconium lattice, small radial cracks were formed. Propagation of these primary cracks occurred via stress oriented, radial hydrides towards the outer surface up to a point where the remaining clad wall failed ductile by necking and 45° angle fracturing. The post-irradiation examination results are discussed in relation to this fracturing mechanism. 23 references. (auth)

8565 IS ZIRCALOY AN ECONOMICAL CLADDING FOR FUEL ELEMENTS? Held, Ch. (Steirische Wasserkraft- und Elektrizitaets-AG, Graz). Atomwirt., Atomtech.; 16: No. 12, 632-3(Dec 1971). (In German).

Because of its superior neutron physical properties, Zircaloy replaced stainless steel as cladding material of fuel elements for pressurized water reactors. Experience showed, however, that Zircaloy cores develop defects ten times more frequently than stainless steel cores. A reevaluation of the two materials was performed from safety and economic standpoints. The study showed that, in spite of initial cost, long-term operation with stainless steel cladding may be more economical than Zircaloy and may be less prone to fission product release. (H.B.G.)

8566 BEHAVIOR OF FUEL RODS AT HIGH BURNUP. Kummerer, K. (Kernforschungszentrum, Karlsruhe, Ger.); Stehle, H.; Weidinger, H. G. Atomwirt., Atomtech.; 16: No. 10, 545-52(Oct 1971). (In German).

Reported are problems of material as well as alterations and failures that occur at high burnups. Treated are fuel rods for boiling water reactors, pressurized water reactors, and fast reactors. Only oxides are discussed because of the fact that, presently, high burnup experience is available only for oxide fuel material. Physical and chemical changes in fuel and cladding, induced by radiation, are discussed. Specific problems of fuel rods are outlined from design to practical installation. (tr-auth)

Auxiliary and Emergency Systems

8567 INSTALLATION FOR THE MONITORING OF CLADDING ON POWER REACTOR FUEL ELEMENTS. Jacobi, S.; Tradowsky, K. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 16: No. 10, 537-8(Oct 1971). (In German).

Methods for the detection of cladding leaks are described for water-cooled and sodium-cooled reactors. In water-cooled reactors, the fission products xenon and krypton are separated from the cooling medium through a carrier gas and then are precipitated. Decay products are measured in a Geiger-Mueller counter. Because of the large radioactivity of the medium itself, small amounts of fission products in the cooling system can be determined only by means of delayed neutron emission. The neutron monitor consists of a sample container with thermal insulation, γ shielding, neutron moderator, and either a helium-3 or boron counting tube. 12 references. (H.B.G.)

Operation and Economics

8568 METHODS OF NUCLEAR kWh PRODUCTION COST CALCULATION. Tessitore, A. Econ. Int. Ponti Energ.; 14: No. 5, 369-444(1970). (In Italian).

The methodological lines of two different procedures for calculating the production cost of nuclear kWh are compared. The first, the present value method applied to average costs, permits estimation of the full cost in the abstract hypothesis that investments and their relative full production be instantaneous; the second, the simplified equilibrium method, allows expression of the technical-economical cost of production in reference to a lapse of time defined in the equilibrium period of the installation. The results obtained from applications of the two procedures are different. (INIS)

8569 DIE LANGFRISTIGE ENTWICKLUNG DER ENERGIEVERSORGUNG UNTER BESONDERER BERUECKSICHTIGUNG DER KERNENERGIE. Vortraege und Diskussionsbeitraege der 15. Arbeitstagung am 13. und 14. Maerz 1969 in Koeln. (Long-Term Energy Requirements With Special Consideration of Nuclear Energy. Proceedings and Discussion Reports of 15th Work Meeting, March 13-14, 1969 in Cologne). Tagungsberichte des Energiewirtschaftlichen Instituts, Heft 15. Muenchen; Verlag R. Oldenbourg (1969). 175p. DM 29.-. (CONF-690352).

Discussed were the inclusion of nuclear energy into the long-term development of energy economics as well as the role of the government in development of nuclear energy for West Germany. Also analyzed was the competition between conventional and nuclear electricity production as well as problems of nuclear fuel supply for various types of energy strategy. Special discussions were devoted to the effect of nuclear energy development on the economics of hard coal, soft coal, natural gas, and oil. (H.B.G.)

8570 FUEL SITUATION: AN ASSESSMENT FOR THE FUTURE. Brandfon, W. W. (Sargent and Lundy, Chicago). Pub. Util. Fortn.; 88: No. 11, 36-40(25 Nov 1971).

The assessment indicates that the era of cheap fossil fuel may be over. A changing demand/supply relationship, coupled with an inflationary economy, will probably force the price of fuel upward at a greater rate than that of technological improvement. This, in turn, will ultimately serve to increase the price of electricity to the consumer. While more of all fuels will be burned to satisfy an increasing demand for energy, the proportion of fossil fuels used to generate electricity probably will decrease because of the expected greater use of nuclear fuel. 10 references. (auth)

Safety and Siting

8571 (AI-AEC-13014) LMFBR SAFETY PROGRAMS. Quarterly Technical Progress Report, July-September 1971. (Atomics International, Canoga Park, Calif.). 15 Nov 1971. Contract AT(04-3)-701. 35p. Dep. NTIS.

LIQUID METAL FAST BREEDER REACTOR—safety programs during July to September 1971
  —coolant pipe rupture in, characteristics of sodium jet discharge from, (E/T)
  —coolant combustion accidents in, release and transport of aerosols and energy from sodium, (E/T)
SODIUM—combustion in liquid metal cooled reactor accidents, release and transport of aerosols and energy from, (E/T)
URANIUM OXIDES UO_2—vaporization in sodium cooled reactor accidents, production and behavior of aerosols from, (E/T)
(H.D.R.)

8572 (ANCR-1009) APPROXIMATION OF SUBCOOLED DEPRESSURIZATION AND CORE HYDRAULIC LOADING IN PWR VESSELS: AN EMPIRICAL METHOD AND COMPUTER APPLICATION. Berta, V. T. (Aerojet Nuclear Co., Idaho Falls, Idaho). Oct 1971. Contract AT(10-1)-1375. 123p. Dep. NTIS.

A method is developed for approximating the subcooled pressure relaxation in the upper and lower plenum of a PWR vessel and the axial hydraulic load on the core for inlet and outlet pipe breaks where the pipe break may be either instantaneous or non-instantaneous. The method, termed the Blowdown Approximation Method, is written in FORTRAN IV under the code name BAM. Results from the method and the code are compared with experimental data from the Semiscale Blowdown and Emergency Core Cooling (ECC) Test Project. The method and the code are discussed relative to application to typical 1000 MW(e) PWR systems. 9 references. (auth)

8573 (ANL-7743) EBR-II: A STATUS REPORT. Smith, R. R.; Loewenstein, W. B.; Walter, C. M. (Argonne National

Lab., Ill.). Jul 1971. Contract W-31-109-eng-38. 203p. Dep. NTIS.

The projected increase of the operational power level of EBR-II from 50 to 62.5 MW(t) during 1970 prompted an examination of the effects of evolutionary changes in core size and composition on reactor safety at 50- and 62.5-MW(t) operation. In general, the approach used is based on a comparison between the expected performance of the system, as it exists now, and the performance evaluated in the original safety documents for much smaller, metal-fueled loadings. The studies show that the expected performance of the reactor and auxiliary systems under steady-state conditions and under various conditions of abnormality is consistent with the intent of the safety documents. 58 references. (auth)

8574 (CONF-711112-5) CRITERIA FOR CONCRETE NUCLEAR CONTAINMENTS. Bender, M. (Oak Ridge National Lab., Tenn.). [1971]. 3p. Dep. NTIS.

From Annual meeting of American Society of Mechanical Engineers; Washington, D. C. (28 Nov 1971).

The engineering requirements inherent in the construction of prestressed concrete containment structures for nuclear reactors are described. The need for a code to establish quality assurance measures for concrete containments is discussed. (H.D.R.)

8575 (UCRL-73408) COMPARATIVE ENVIRONMENTAL COSTS OF ENERGY SOURCES; A PERSPECTIVE. Watson, Donald E. (California Univ., Livermore. Lawrence Livermore Lab.). 1 Nov 1971. 15p. (CONF-711119-4). Dep. NTIS.

From sixth annual topical symposium on radiation protection standards; Richland, Wash. (2 Nov 1971).

The procedures used in cost-benefit analyses of nuclear and fossil fuel power plants are described. The importance of public acceptance of the alternatives available in these analyses is stressed, and the need for more comprehensive definitions of environmental costs of energy production is discussed. 16 references. (H.D.R.)

8576 LIQUID POISON SAFETY DEVICE FOR NUCLEAR REACTORS. Fonteray, Pierre; Vrillon, Bernard (to Commissariat a l'Energie Atomique). French Patent 2,063,938. 16 Jul 1971. Filed 7 Oct 1969. (In French).

A liquid poison safety device for a nuclear reactor is described; it consists of a U tube with an arm crossing the reactor core, the other arm being connected to the bottom of the liquid poison reservoir. A directly communicating circuit enables the liquid levels in the two arms of the U tube to be made equal during the poisoning of the core. Another circuit allows the pressure in the two branches of the U tube to be regulated above that of the liquid poison and the control of a superpressure in the internal branch, so that the liquid poison can be evacuated into a reservoir outside the reactor core. These two circuits are situated between the reservoir and the branch of the U tube crossing the reactor core. (France)

Power Conversion Systems

8577 OPERATING EXPERIENCE WITH HOT AIR POWER PLANT AND DEVELOPMENT OF HELIUM POWER STATIONS. Deuster, G.; Pluer, R. Mitt. Ver. Grosskesselbetr.; 51: No. 2, 81-91(1971). (In German).

Following an explanation of the differences in the operation of hot air turbines and steam turbines, the experience gained from almost ten years of operation is reviewed. Findings encourage the change-over to helium turbines in conjunction with high-temperature reactors. As a first stage in this direction, a 50-MW helium turbine with conventional combustion chambers is being contemplated. (INIS)

Research and Test Reactors

Refer also to abstract 6900.

8578 (70-CNA-662) TAIWAN RESEARCH REACTOR PROJECT. Orlando, F. W. (Canatom Ltd., Montreal (Quebec)). 1970. 9p. (CONF-700564-16). Dep. NTIS (U. S. Sales Only).

From tenth annual international conference of the Canadian Nuclear Association; Toronto, Canada (24 May 1970).

Design parameters and operations aspects for the 40 MW(t) Taiwan Research Reactor are presented. (D.C.C.)

8579 (AECL-3795) RADIATION DOSIMETRY IN WR-1 REACTOR. PART I. CALORIMETRY. Mehta, K. K.; Stadnyk, A. M. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Oct 1971. 44p. Dep. NTIS (U. S. Sales Only). AECL $1.50.

A calorimeter for measuring radiation energy deposition in nuclear reactors has been developed which is capable of continuous operation at temperatures up to at least 550°C. It is sufficiently small (<11 mm diameter) to be incorporated within in-core experiments without significant flux depression. It is rugged, simple in construction, reliable and accurate to within 5%. Total dose rates were measured in the WR-1 reactor. The values at the center line of the fuel rod for graphite, magnesium, iron and Zircaloy-2 are 132, 110, 104 and 116 $\text{mW} \cdot \text{g}^{-1}/\text{kW} \cdot \text{cm}^{-1}$, respectively. 23 references. (auth)

8580 (HEDL-TME-71-18(Rev.1)) FEASIBILITY OF LITHIUM ADDITION AS AN ALTERNATE SHUTDOWN METHOD FOR THE FAST TEST REACTOR. Schively, D. P. (Hanford Engineering Development Lab., Richland, Wash.). Feb 1971. Contract AT(45-1)-2170. 45p. Dep. NTIS.

The use of lithium as a liquid poison in an alternate shutdown system for the FTR was investigated. Shutdown methods considered included addition of ^{6}Li to the primary coolant, to a closed loop, or to an open thimble and provision of a Li-Sb fusible plug. The relative worths of the methods are presented. It was concluded that the use of Li as a rapid shutdown method is not advisable. 11 references. (H.D.R.)

8581 (ORNL-TM-3655) HIGH FLUX ISOTOPE REACTOR QUARTERLY REPORT, JULY-SEPTEMBER 1971. McCord, R. V.; Corbett, B. L. (Oak Ridge National Lab., Tenn.). 24 Oct 1971. Contract W-7405-eng-26. 24p. Dep. NTIS.

The semiannual in-vessel component inspection took place during the quarter. During the inspection new bearings were mounted on the upper and lower tracks and reworked control-rod extension tubes were installed. The extra downtime required for this routine maintenance reduced the on-stream time to 93.7%. A small leak developed in one of the primary heat-exchanger tubes. This is the first heat-exchanger-tube leak in three years. The leaking tube was located and plugged without difficulty. (auth)

Rocket and Space Reactors

8582 (NAA-SR-12437) CRU-V DEVELOPMENT STATUS AND CAPABILITY. Ellis, D. E.; McDonald, J. S.; Howard, J. M. (Atomics International, Canoga Park, Calif.). 29 Jun 1967. Contract AT(04-3)-701. 155p. Dep. NTIS.

The development status of the SNAP 2/Mercury Rankine Program's combined rotating unit (CRU-V) is reviewed. Included are the test results through September 1966. The pertinent operational characteristic of not only the individual components but also the results of component interactions are included. Fabrication and quality control considerations are also discussed. The additional development which would be required before the CRU would be considered operational is delineated. (auth)

8583 (TRW-690-27) MERCURY RANKINE POWER CONVERSION PROGRAM. Quarterly Progress Report, April-June 1967. (TRW Equipment Labs., Cleveland, Ohio). Contract AT(04-3)-690. 61p. (TRW-ER-7160). Dep. NTIS.

Endurance tests on two mercury vapor turboalternator power conversion systems for the SNAP reactor program are reported. The combined rotating unit (CRU) testing consisted of endurance testing of CRU V-3E and acceptance and endurance testing of CRU V-4E. Corrosion product control investigations indicated a low level of contaminant in the liquid mercury portion of the systems during operation. Detailed data are presented on operation of both the power conversion systems and the test cells. (H.D.R.)

8584 (TRW-690-34) MERCURY RANKINE POWER CONVERSION PROGRAM, CRU V DESIGN AND DEVELOPMENT. Bell, T. A.; Weinhold, H.; Caponero, S. J.; Simler, J. S. (TRW Equipment Labs., Cleveland, Ohio). 15 Feb 1968. Contract AT(04-3)-690. 346p. (ER-7254). Dep. NTIS.

The development program of the CRU V turbo-alternator, which is intended for use in the SNAP 2 Mercury Rankine Power Conversion System, is summarized. A brief review of the CRU development history as well as design descriptions and discussions of the CRU V test results for the overall configuration and its major components are presented. The methods of test data analysis and the status of development, including remaining problem areas, are discussed. References pertaining to the component development are also furnished. Special emphasis is placed on the performance of the finally evolved CRU V design. 21 references. (auth)

Process Heat and Desalination Reactors

8585 MULTI-PURPOSE UTILIZATION OF NUCLEAR REACTORS. DEVELOPMENT OF REACTOR UTILIZATION IN ENERGY-COLLECTIVE INDUSTRIAL COMPLEX. Suetsuna, Ichiro (Japan Atomic Industrial Forum, Inc., Tokyo). Shigen; No. 177, 46-53(Nov 1970). (In Japanese).

Multi-purpose utilization of nuclear reactors introduced into an industrial complex is reviewed. Benefits from employment of nuclear reactors in the industrial complex are reviewed, pointing out the various aspects of utilization. (Japan)

8586 TECHNICAL AND ECONOMIC INDICES FOR NUCLEAR POWER PLANTS WITH SALT WATER DISTILLING EQUIPMENT. Gubenko, V. V. Energet. Elek.; No. 3, 45-6(1971). (In Russian).

For purposes of mathematical treatment a basic equation is given for an operating complex, consisting of nuclear power plant generating heat and electrical power to feed a desalination process, and showing power consumption in terms of rubles/kWh and rubles/m^3 of distillate. The results of two sets of calculations are tabulated, based on 250 and 500 rubles/kg, respectively, as the potential costs of nuclear fuel. (K.S.W.)

8587 HIGH TEMPERATURE GAS-COOLED REACTOR: A PROCESS HEAT/ELECTRICAL ENERGY SOURCE FOR A LARGE STEELWORKS. Hawkes, D. A. (British Steel Corp., Teesside, Eng.); Hosegood, S. B. J. Brit. Nucl. Energy Soc.; 10: No. 4, 308-20(Oct 1971).

The possible types of direct reduction and steelmaking processes that could be integrated into a plant complex using a high temperature gas cooled reactor as the process heat and electrical energy source are discussed, and a suitable overall process route is suggested using present-day technological knowledge. An attempt is made to compare the cost of steel products from such a complex with those from a traditional blast furnace/oxygen steelmaking route. The development problems to be encountered, and possible solutions to these problems, are discussed together with some thoughts on future trends in technological and economic factors. (auth) (UK)

Marine and Portable Power Reactors

8588 (DOCKET-50238-86) N. S. SAVANNAH. Discussion of Inspections of Defueling Activities. (Division of Compliance (AEC), Denver, Colo. Region IV). 2 Dec 1971. 10p. Dep. NTIS.

8589 (DOCKET-50238-87) N. S. SAVANNAH. Technical Specifications, Change No. 12. (Division of Reactor Licensing (AEC), Washington, D. C.). 20 Dec 1971. 4p. Dep. NTIS.

Revised technical specifications are presented to permit the ship to be towed, berthed, moored or drydocked in the defueled condition at any domestic location having an approved port entry and docking plan. (D.C.C.)

8590 NUCLEAR SHIP PROPULSION: SAFETY PROBLEMS. Illies, K. (Technische Univ., Hanover). Schiff Hafen; 23: No. 1, 27-30(1971). (In German).

The normal accident-free operation and the case of accidents during operation are described. A comparison of "inner safety" for operation personnel and "outer safety" for the environment is presented. (INIS)

Reactor Theory

8591 (LFEN-NI-63-a) URDO: FORTRAN PROGRAM LFEN-FR 8 FOR CALCULATION OF HEAVY WATER LATTICES. Jorge, H. Machado (Junta de Energia Nuclear, Sacavem (Portugal). Labratorio de Fisica e Engenharia Nucleares). 1970. 41p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

URDO is a Fortran II program for the calculation of UO_2(natural)—D_2O and U(natural)—D_2O lattices. It is applied to two types of fuel elements: rods and seven-rod bundles. The program permits the calculation of the values of ϵ, η, p, f, and k_∞. The program contains an interpolation subprogram INTPOL. (tr-auth)

8592 (Y-CDC-10) CRITICALITY OF CUBIC ARRAYS OF FISSILE MATERIAL. Thomas, J. T. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 3 Nov 1971. Contract W-7405-eng-26. 64p. Dep. NTIS.

Calculated criticality data of water-reflected arrays containing subcritical components of ^{235}U, ^{239}Pu, and ^{233}U are presented in tabular form. The calculations were performed with the KENO Monte Carlo code and used the Hansen-Roach 16-group neutron cross-section sets. The response of the array neutron multiplication factor to changes in the mass of the units provides a systematic measure of subcriticality for nuclear criticality safety specifications. The effect of concrete replacing water as a reflector was investigated as well as the neutron interaction between arrays when separated and reflected by concrete. A number of practical applications to criticality safety problems is suggested and guidance is provided for the storage of fissile materials. (auth)

8593 (ZJE-105) TRANSPORT CORRECTION OF HIGHER ORDER AND REMOVAL SYSTEMS. Valenta, V.; Veverka, O.; Krysl, V. (Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Construction Dept.). 1971. 60p. Dep. NTIS (U. S. Sales Only).

The transport corrections of higher order are presented. The results are applied on removal systems. The removal diffusion and removal P1 systems based on the transport equations of higher order are compared with the NRN method and Spiney's method. 11 references. (auth)

Kinetics

8594 (GEAP-13740) TDOWN: A CODE TO GENERATE COMPOSITION AND SPATIALLY DEPENDENT CROSS SECTIONS. Cowan, C. L.; Hutchins, B. A.; Turner, J. E. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Aug 1971. Contract AT(04-3)-189. 124p. Dep. NTIS.

TDOWN generates space- and composition-dependent cross-section sets from a Bondarenko-type generalized cross section file. A TDOWN problem can be a simple description of material compositions with an input flux spectra, or a problem can consist of a multi-regional two-dimensional reactor description with several 0- or 1-dimensional flux solutions to provide the flux for spectral adjustments of the cross-section sets. TDOWN uses the rapid cross section adjustment procedure and a generalized file. For each material, the file contains the groupwise values of infinitely-dilute cross sections; resonance self-shielding factors, which are tabulated for temperatures and a range of σ_0's—the material-composition-dependent parameter; and scattering matrices. Self-shielding of a cross section is accomplished by computing σ_0 and using interpolation routines to determine the self-shielding factor for the σ_0 and input temperature. Self-shielding is an iterative procedure with the convergence criteria specified in the input. Problems with all the flux spectra read use a maximum of a few minutes on the GE635. A 29-energy-group problem generating 100 materials in 15 compositions with the flux spectra computed by two 1-dimensional flux solutions, 9 iterations each, required 0.3 hours of computer processor time. Written in FORTRAN, the program requires 32K of computer memory on the GE635. This includes a 10K overlap with the loading routines. In addition to the card reader and printer devices, three tape handlers and six files on a peripheral device are required. (R.W.R.)

8595 (TKK-F-A-149) ACCURACY ANALYSIS OF IRESINT2: A RESONANCE INTEGRAL COMPUTER PROGRAM. Wasastjerna, Frej (Helsinki Univ. (Finland). Dept. of Physics). 10 Aug 1971. 39p. Dep. NTIS (U. S. Sales Only).

The accuracy of the resonance absorption code IRESINT2, which uses the IR approximation with or without interferences scattering or the NR approximation, is studied by comparison with results from other codes and from experiments for various systems, chiefly square lattices with ^{238}U as the absorber. 19 references. (auth) (Finland)

8596 ERROR ESTIMATION OF PROMPT JUMP APPROXIMATION BY SINGULAR PERTURBATION THEORY. Asatani, Koichi; Iwazumi, Tetsuo; Hattori, Yoshio (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo); 8: No. 11, 653-6(Nov 1971).

A refined error estimation of the prompt jump approximation is presented. The accuracy is improved in preparation for the synthesis of the suboptimal control of reactor systems. 12 references. (auth)

8597 APPLICATION OF NEUTRON WAVE CONCEPTS TO THE DESIGN AND INTERPRETATION OF POWER REACTOR NOISE MEASUREMENTS. Braun, Joseph Carl. Pittsburgh; Carnegie-Mellon Univ. (1971). 109p. University Microfilms Order No. 71-24,847.

Thesis.

Spatially varying neutron level fluctuations in a light water power reactor core are interpreted as neutron waves emanating from an imposed or intrinsic disturbance. A one-velocity wave model which includes slowing down and feedback effects is developed by solving the space-time diffusion equation for the case of a steady oscillating source. A fermi-age treatment is used for neutron slowing down effects. Fuel and moderator temperature feedback is accounted for by solving the respective heat balance equation for a modulating heat source. Void feedback effects are accounted for by fitting a two time constant empirical formula to a more sophisticated calculational technique. Results from this wave model are compared to results from subcritical experiments, modal calculations, and numerical transfer function calculations. These comparisons indicate that a relatively simple wave model can be used to interpret a wide variety of neutron fluctuation experiments with sufficient accuracy to justify its use in the design and interpretation of neutron fluctuation experiments in power reactors. The wave approach suggests two applications of spatial noise measurements in power reactors. The first would use the cross-correlated noise signals from three or more in-core detectors to find the location of a fluctuating disturbance. The second would use an in-core oscillator along with several in-core detectors to monitor core regions for changes in wave propagation properties that would signal changes in local multiplication or feedback. (Diss. Abstr. Int. B.)

8598 REACTOR LATTICE CALCULATIONS USING INVARIANT IMBEDDING AND A DEGENERATE THERMALIZATION KERNEL. Versluis, Rob M. Tallahassee, Fla.; Univ. of Florida (1970). 219p. University Microfilms Order No. 71-24,983.

Thesis.

The generalized invariant imbedding formalism for neutron transport problems is described. Presented are the results of these attempts under the restricting conditions of linear imbedding in the context of unit cell calculations. The revelation of the close connection between linear imbedding and the theory of large perturbations of the transport equation is probably the main achievement. The tool of generalized invariant imbedding, the generalized resolvent equation, is presented, and its connection to conventional invariant imbedding is demonstrated. Part of the invariant imbedding effort entailed the search for an accurate degenerate kernel that can be used to represent the exact thermalization kernel. This was necessitated by the poor results for the calculation of thermal neutron spectra when conventional degenerate kernels were used. A new kernel was developed, the DESKETE kernel (for DEgenerate Scattering Kernel with Epi-Thermal Eigenvectors), which enables one to calculate thermal neutron densities very accurately and, as opposed to conventional degenerate kernels, shows the desirable feature that the accuracy improves when the number of terms in the degenerate kernel is increased. The success of the DESKETE kernel is based on the admission of the first few eigenfunctions of the scattering kernel, arranged according to the magnitude of the eigenvalue, for the reproduction of scattering involving epi-thermal energies. The other terms in the DESKETE kernel are combinations of the velocity (or energy) moments of the strictly thermal part of the scattering kernel. (Diss. Abstr. Int. B.)

8599 CONSTRUCTION OF NUCLEAR POWER DISTRIBUTIONS USING FIXED IN-CORE DETECTOR DATA. Ryals, Henry Wesley. Pittsburgh; Carnegie-Mellon Univ. (1971). 138p. University Microfilms Order No. 71-24,864.

Thesis.

A general method is formulated for approximating few group flux distributions in an operating nuclear power reactor by using variational synthesis. The trial functions used in the synthesis technique are defined by multiplying a set of reference functions by a set of shaping functions formed from low order polynomials. When in-core detectors are used to define the mixing coefficients of a given flux group, the mixing coefficients of the other group (2-group scheme) can be solved for in a fixed source mode. The eigenvalue mode of solution can be used for design calculations or to ascertain shutdown margin capabilities. Results are presented in two dimensions to indicate the order-of-accuracy that can be expected when applying the theory to an operating core. Calculations performed for radial and axial configurations provide information to determine the number and location of detectors necessary for monitoring an operating core, provide information to the operator to determine power distributions within the core, provide a basis for short and long term optimization of the core operation, and provide a means of coupling detector signals to neutron balance calculations for on-line detection of abnormal conditions in the core or to detect spurious detector signals. (Diss. Abstr. Int. B.)

8600 MODERATOR CORRECTION FOR A WIDE RESONANCE BY THE GREULING-GOERTZEL APPROXIMATION. Takeda, Toshikazu; Azekura, Kazuo; Sekiya, Tamotsu (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 8: No. 11, 649-50(Nov 1971).

Experimental Applications

8601 (NP-19086) EXPERIMENTAL STUDIES OF EFFECTIVE CROSS SECTIONS, REACTION RATE DISTRIBUTIONS AND NEUTRON SPECTRA IN SOME FAST REACTOR CORES. Andersson, Tor Leif (Aktiebolaget Atomenergi, Studsvik (Sweden)). 1971. 18p. Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Lund Univ., Sweden.

Four types of measurements at the fast critical facility FRO are described. (1) Reaction rate ratios and distributions were measured in different cores with miniature fission counters and with foil activation techniques. The five structure in spatial neutron flux distribution due to core heterogeneity has been studied and compared with calculations. The heterogeneity effect was in several cores greatly reduced by the use of very thin plates of the core constituent materials. (2) Spectrum measurements with resonance sandwich detectors were performed in three FRO-cores with relatively soft spectra. The ^{197}Au, ^{186}W, ^{55}Mn and ^{23}Na resonances were utilized and the counters were calibrated in a well known epithermal spectrum in the thermal reactor R1. Comparison with calculations gave good agreement for two uranium cores while the calculated spectrum for a plutonium core was found to be too hard. (3) The capture to fission ratio for ^{239}Pu and ^{235}U was measured by an integral method. The reactivities of small samples of the fissile isotopes and a boron standard were measured together with the absolute fission rates and the reaction rate, respectively. The measurements made in two rather soft spectra support rather high α-values and are obtained with experimental uncertainties between 1.5 and 4.5 per cent. Calculated values lie within the experimental uncertainties. (4) The reactivity worths of 10 main fission products and fission product mock-up sample were determined by the pile-oscillator techniques in three fast reactor spectra. Corresponding calculated values are generally found to be higher. (Sweden)

8602 ON-LINE COMPUTATION OF POWER DISTRIBUTIONS FOR SHORT TERM NUCLEAR POWER REACTOR RESPONSE TO OPERATIONAL TRANSIENTS. Savoia, Peter John. Pittsburgh; Carnegie-Mellon Univ. (1971). 175p. University Microfilms Order No. 71-24,866.

Thesis.

Methods have been developed whereby in-core monitoring devices are used in conjunction with an on-line computer to adequately specify the state of an operating power reactor. Given this ability to specify the initial conditions of the reactor system, a logical extension is the use of the on-line computer to predict the response of the reactor to short term maneuvering transients. A model of the system which will enable fast running and accurate predictions to be made is presented. A nodal model of the reactor has been developed which yields accurate predictions of the core multiplication constant and power distributions. In applications utilizing a relatively coarse nodal configuration, the multiplication constant is accurate to better than 0.4%, while the fractional nodal power is accurate to 6.0%. The advantage of this model, with respect to most existing nodal methods, is that the nodal parameters can be determined directly from calculations, and do not require empirical "fitting" to match a given power distribution. The estimated active core storage necessary to represent a typical 1,000 MW(e) pressurized water reactor is less than 32,000 words. Running times for the present versions are large; however, modifications to the numerical iteration strategy should eliminate this difficulty. (Diss. Abstr. Int., B.)

8603 DETERMINATION OF ^{235}U IN IRRADIATED FUEL ELEMENTS BY REACTIVITY MEASUREMENTS. Harrington, J. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Vienna). Atomwirt., Atomtech.; 16: No. 12, 634-5(Dec 1971).

A method for determination of the ^{235}U content of irradiated MTR-type fuel elements using only a normally equipped research reactor is described. The method is based on a series of reactivity measurements with several fuel elements placed in succession at a single test position. (H.D.R.)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 6957, 7151, 7217, and 7253.

8604 METHOD OF PULSATING OR MODULATING A NUCLEAR REACTOR. Van Dievoet, Jean Paul; Fossoul, Emile; Stievenart, Michel; (and others). (to Siemens Aktiengesellschaft). U. S. Patent 3,489,646. 13 Jan 1970. Priority date 24 Apr 1963, Germany.

REACTORS—pulsing system for, design characteristics of synchronized rotating dual core sections for (D.C.C.)

8605 IMPROVEMENTS IN OR RELATING TO TRANSDUCERS. Hughes, Gordon (to United Kingdom Atomic Energy Authority). British Patent 1,252,257. 3 Nov. 1971. Filed 28 Dec 1967.

Reference is made to a device which may be employed to detect blockage in liquid metal reactor coolant circuits. It is essentially a conductivity sensor. A rise in temperature of the fuel due to coolant blockage causes temperature fluctuations that in turn cause conductivity changes. The sensor comprises a coil assembly having four conductors forming two pairs of windings connected as pairs into adjacent arms of a unity ratio bridge. The coil assembly preferably comprises a stainless steel sheathed mineral insulated cable, although the sheathing may be composed of other non-magnetic material of fairly high resistivity. (UK)

8606 DEVICE FOR SUPPORTING THE CENTERING ELEMENTS OF A FUEL ELEMENT IN THE LONGITUDINAL GROOVES OF AN ANNULAR EXTERNAL SLEEVE. Marinot, Robert; Sionnet, Jean (to Commissariat a l'Energie Atomique). French Patent 2,061,560. 25 Jun 1971. Filed 1 Jul 1969. (In French).

A device for supporting, at high temperatures, the radial centering elements of a nuclear fuel element in an external sleeving, is described. These elements, which may, or may not be rigidly connected to the fuel element, are regularly distributed about the fuel element; they are located in longitudinal grooves provided around the inner surface of the sleeve. The device facilitates a flexible positioning of the centering elements in these grooves and consists of metallic springs which are housed, at least partially, between each centering element and the longitudinal groove in which it is located. These springs possess a radially extended part by which they are fixed to the sleeve. (France)

8607 SINGLE WALL NaK CAPSULE FOR IRRADIATION OF HIGH-POWER FUEL RODS. Haefner, H. E. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 16: No. 12, 638-9(Dec 1971). (In German).

In July 1971, a single-walled NaK capsule with a carbide fuel rod was first installed for irradiation in the Karlsruhe research reactor FR 2. Within the fast breeder project, irradiation of approximately 25 rods was projected. Dimensions and operational data for the carbide fuel rods are tabulated. Construction of the single-walled capsule and its rods is depicted in a diagram. From a safety standpoint, the NaK-water reaction claims special significance in the case of capsule leaks. Several experiments were performed and the findings are described with respect to rate of pressure increase, pressure maximum, and duration. (H.B.G.)

8608 ANISOTROPIC CHANGES THROUGH IRRADIATION AND HEATING IN PYROCARBON COATINGS OF FUEL ELEMENT PARTICLES. Balthesen, E.; Koizlik, K. (Kernforschungsanlage, Juelich, Ger.). Atomwirt., Atomtech.; 16: No. 12, 635-7(Dec 1971). (In German).

The orientation anisotropy of pyrocarbon fuel particle coatings was measured with an optical method. Various types of particles were exposed to neutrons of doses up to 16×10^{21} cm^{-2} ($E > 0.1$ MeV) and burnups to 15%. The anisotropy increased with neutron dose. At higher burnups, the neutron dose effect was more pronounced. The effects probably reflected stress-enhanced graphitization. Oxide as well as graphite particles with various types of coating were heated for 60 min to temperatures between 1800 and 2400°C. Anisotropic effects of the various procedures are presented. (H.B.G.)

GENERAL

8609 (AEC-tr-7289) SELECTIVE DEVELOPMENT OF PITS IN A STAINLESS STEEL IN AN OXIDIZING CHLORIDE MEDIUM. Monnier, Anne; Coriou, Henri; Pinard-Legry, Gerard; Plante, Georges. Translated from Compt. Rend., Ser. C; 271: No. 16, 981-4(1970). 5p. Dep. NTIS.

8610 (ANCR-1037) TRANSIENT RESPONSE OF TRANSDUCERS. Definitions and Characteristics. Colson, J. B.; Meservey, R. H. (Aerojet Nuclear Co., Idaho Falls, Idaho). Nov 1971. Contract AT(10-1)-1375. 33p. Dep. NTIS.

8611 (ANL/ES-7) AIR POLLUTION-LAND USE PLANNING PROJECT. Phase I. Final Report: July 1971. Kennedy, Allen S.; Cohen, Alan S.; Croke, E. J.; Croke, K. G.; Stork, J.; Hurter, A. P. (Argonne National Lab., Ill.). Nov 1971. Contract W-31-109-eng-38. 153p. Dep. NTIS.

8612 (BDX-613-430) ELECTROCHEMICAL STUDIES OF THE GOLD–COPPER ELECTROPLATING BATH. Klingsporn, P. E. (Bendix Corp., Kansas City, Mo.). Nov 1971. Contract AT(29-1)-613. 90p. Dep. NTIS.

8613 (BDX-613-472) ELECTRICAL TERMINATIONS: WELDED, BRAZED, AND BONDED. Quarterly Report, FY71-4. Stittsworth, D. E. (Bendix Corp., Kansas City, Mo.). Oct 1971. Contract AT(29-1)-613. 59p. Dep. NTIS.

8614 (BDX-613-522) EVALUATION OF FOAM MIXING MACHINES. Final Report. Hetzler, R. F. (Bendix Corp., Kansas City, Mo.). Nov 1971. Contract AT(29-1)-613. 25p. Dep. NTIS.

8615 (BNL-16224) HIGH-SPIN–LOW-SPIN AND STRUCTURAL TRANSITION IN LaCoO$_3$. Bari, Robert A. (Brookhaven National Lab., Upton, N. Y.). [1971]. 10p. (CONF-711108–6). Dep. NTIS.

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

8616 (BNL-16270) AGRICULTURAL SOLID WASTE: A NATIONAL ENERGY SOURCE. A BY-PRODUCT OF A FOOD PRODUCTION. Steinberg, Meyer (Brookhaven National Lab., Upton, N. Y.). Sep 1971. 10p. Dep. NTIS.

8617 (BNL-16276) CRITICAL TEMPERATURES IN Fe-DOPED COPPER-RICH Cu–Ni ALLOYS. Bennett, L. H.; Swartzendruber, L. J. (National Bureau of Standards, Washington, D. C.); Watson, R. E. (Brookhaven National Lab., Upton, N. Y.). [1971]. 6p. (CONF-711108–4). Dep. NTIS.

From Conference on magnetism; Chicago, Ill. (16 Nov 1971).

8618 (BNL-16326) MAGNETIC STRUCTURE AND MOESSBAUER STUDIES OF THE LAYER ANTIFERROMAGNETS α-RbFeF$_4$ AND KFeF$_4$. Eibschuetz, M.; Davidson, G. R.; Guggenheim, H. J. (Bell Telephone Labs., Inc., Murray Hill, N. J.): Cox, D. E. (Brookhaven National Lab., Upton, N. Y.). [1971]. 10p. (CONF-711108-8). Dep. NTIS.

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

8619 (BNL-16327) MAGNETIC ORDERING IN A LINEAR CHAIN COMPOUND RbFeCl$_3$. Davidson, G. R.; Eibschuetz, M. (Bell Telephone Labs., Inc., Murray Hill, N. J.); Cox, D. E.; Minkiewicz, V. J. (Brookhaven National Lab., Upton, N. Y.). [1971]. 5p. (CONF-711108–7). Dep. NTIS.

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

8620 (BNL-16334) EXPERIMENTAL DATA ON DISPERSION AND DEPOSITION OF POLLENS FROM LOW-LEVEL, CROSSWIND LINE SOURCES. Raynor, Gilbert S.; Hayes, Janet V.; Ogden, Eugene C. (Brookhaven National Lab., Upton, N. Y.). Nov 1971. 63p. Dep. NTIS.

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